Masters

7858A/7878A FLUID RECORDING SYSTEM

MP-51516

OPERATING AND SERVICE MANUAL

Preliminary

MP MASTER
MA27420

HEWLETT hp PACKARD
RECORDING SYSTEMS

PIM-7858A-1

HEWLETT PACKARD SANBORN DIVISION

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7858A/7878A FLUID RECORDING SYSTEM

OPERATING AND SERVICE MANUAL

PRELIMINARY

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MANUAL CHANGES

MODEL 7858A/7878A

FLUID RECORDING SYSTEM
(MANUAL TITLE)

MANUAL PREFIXED: PIM-7858A-1

MAKE ALL CHANGES IN THIS MANUAL ACCORDING TO THE ERRATA BELOW. ALSO CHECK THE FOLLOWING TABLE FOR YOUR INSTRUMENT CR/PCO NUMBER AND MAKE ANY LISTED CHANGE(S) IN THE MANUAL.

CR/PCO Number	Make Manual Changes	CR/PCO Number	Make Manual Changes
ALL	ERRATA		

Δ NEW OR REVISED ITEM

ERRATA: Page 1-2, Frequency Response;
Change second sentence to read, "Typical - 3dB point for 50 division deflection is 80 Hz".

Page 1-7, Figure 1-4;
Change to read "7858-64000 Driver Power Supply".

Page 2-9, Figure 2-9;
Change to read "System Controls, Model 7878A".

Page 3-1, Table 3-1;
Delete line titled "Diazo duplicators (9280-0080 and 9280-0081 papers)".

Page 3-3, Figure 3-2, Item 7;
Change to read "CHART DRIVE controls: RUN, STDBY, REMOTE. REMOTE pushbutton transfers Chart Drive and Marker controls to remote station. Interchange numbers 4 and 7 on photo".

Page 3-4, Figure 3-3, Item 2;
Change to read "Press CHART DRIVE STDBY button".

Page 3-4, Figure 3-3, Item 6;
Change to read "Press Recorder POWER switch if chart illuminator is not lighted. Allow 5 minutes warmup time".

Page 3-4, Figure 3-3, Item 7;
Change to read "Press CHART DRIVE RUN button".
Interchange numbers 6 and 7 on photo.

October 30, 1967
DATE

EPIM-7858A-1A
SUPPLEMENT NUMBER

.100

ERRATA: (Cont.)

Page 3-5/6, Figure 3-4, Item 4;
Change Note to read "See Figure 3-5 for spindle location".

Page 6A-6, Control Panel Parts List;
Add the following assembly:

Assembly, Terminal Board HP No. 07850-63150.

Qty.	Part No.	Description
1	1853-0045	Transistor (Q1)
1	0687-2721	Resistor, 270 ohm, 10%, 1/2W (R1)
1	0811-1799	Resistor, 390 ohm, 5%, 3W (R2)
1	0811-1219	Resistor, 250 ohm, 2%, 3W (R3)
1	07850-03150	Board, P. C.

Page 6A-6, Figure 6A4-9;
Change Part No. and Description to read "5000-0339, Label, Switch (STDBY).

Page 6A-6, Figure 6A4-40;
Add the following items:

Qty.	Part No.	Description
2	0180-0049	Capacitor, 20 μF (C5, C6)
1	0761-0015	Resistor, 1.5K, 1W (R1)
1	0761-0035	Resistor, 150 ohm, 1W (R2)
1	1853-0045	Transistor (Q1)
3	1901-0039	Diode (CR1, CR2, CR3)

Page 6A-6, Figure 6A4-42;
Add the following items:

Assembly, Marker Switch, HP No. 07850-63040 consisting of:

Qty.	Part No.	Description
1	0180-0235	Capacitor, 56 μF (C1)
1	1901-0039	Diode (CR1)
1	3101-1028	Switch, Marker (S1)

Page 6A-41, Transfer Chassis Assembly (Index No. 37);
Add the following items:

Qty.	Part No.	Description
2	0490-0467	Relay, 4PDT
2	1200-0170	Socket, Relay

ERRATA: (Cont.)

Page 6A-51/52, Figure 6A21;
Add revised Control Panel schematic. Change S2 Chart Drive switch OFF position to read STDBY.

Page 6A-57/58, Figure 6A24;
Add revised Power Supply schematic.

Page 6A-59/60, Figure 6A25;
Add revised Transfer Chassis schematic.

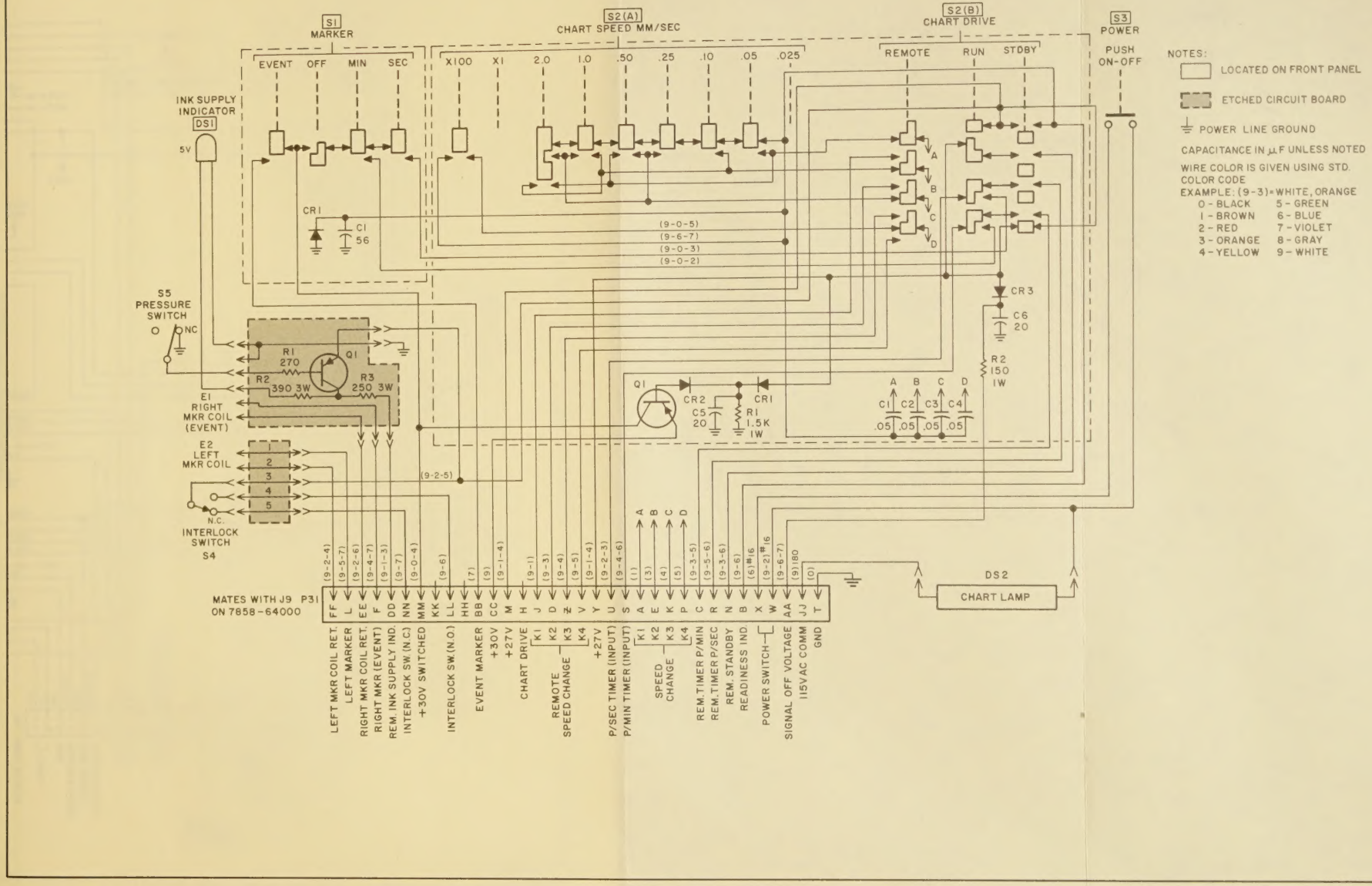
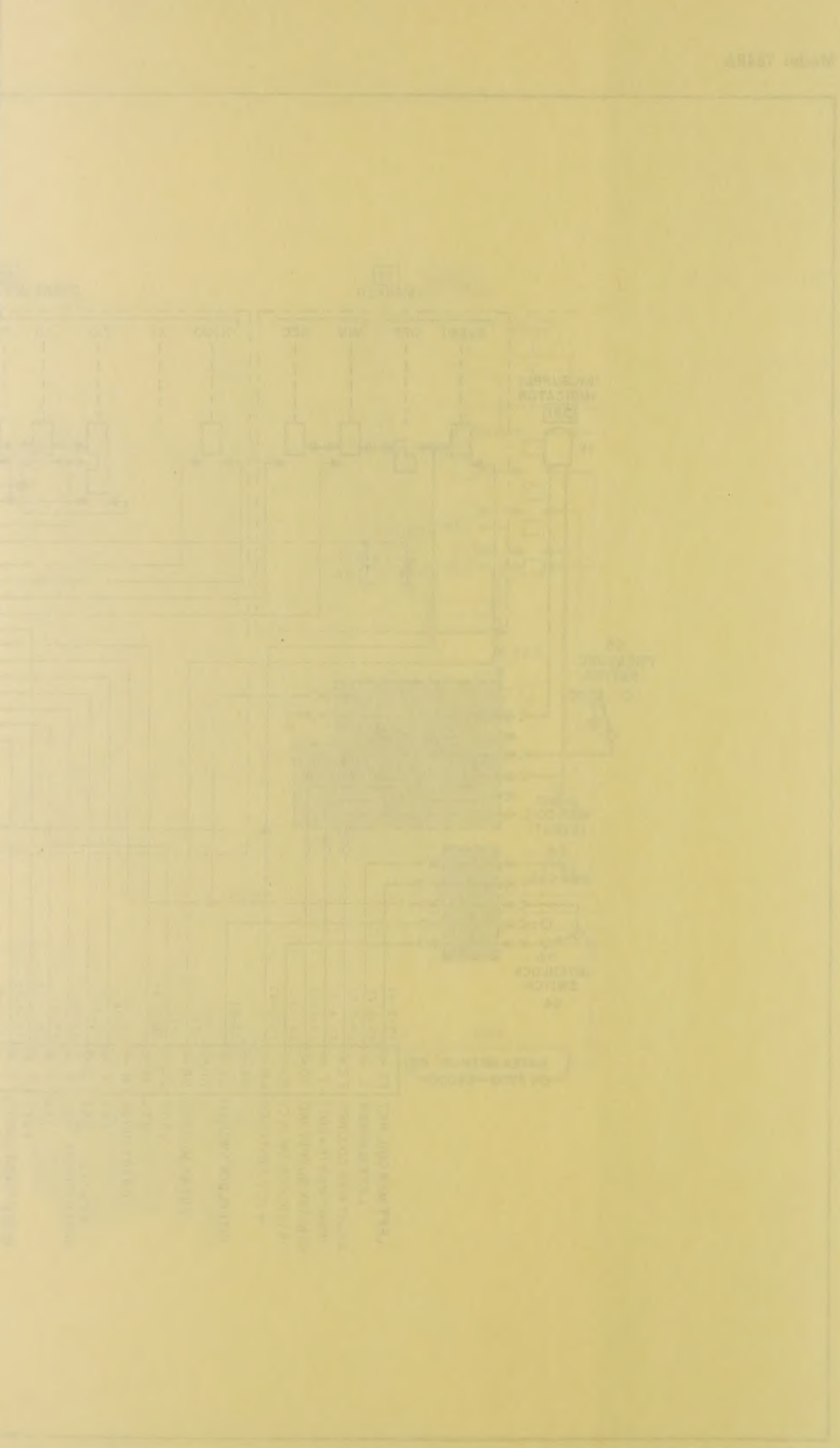
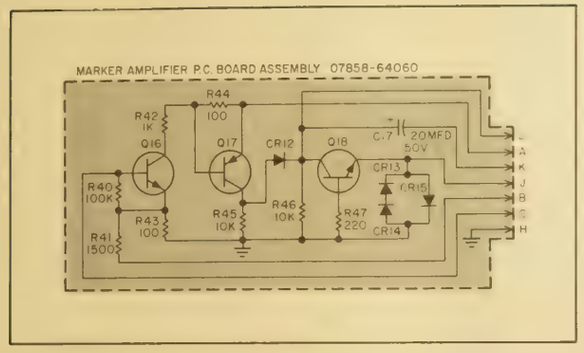


Figure 6A21. Control Panel Schematic for Model 7848A





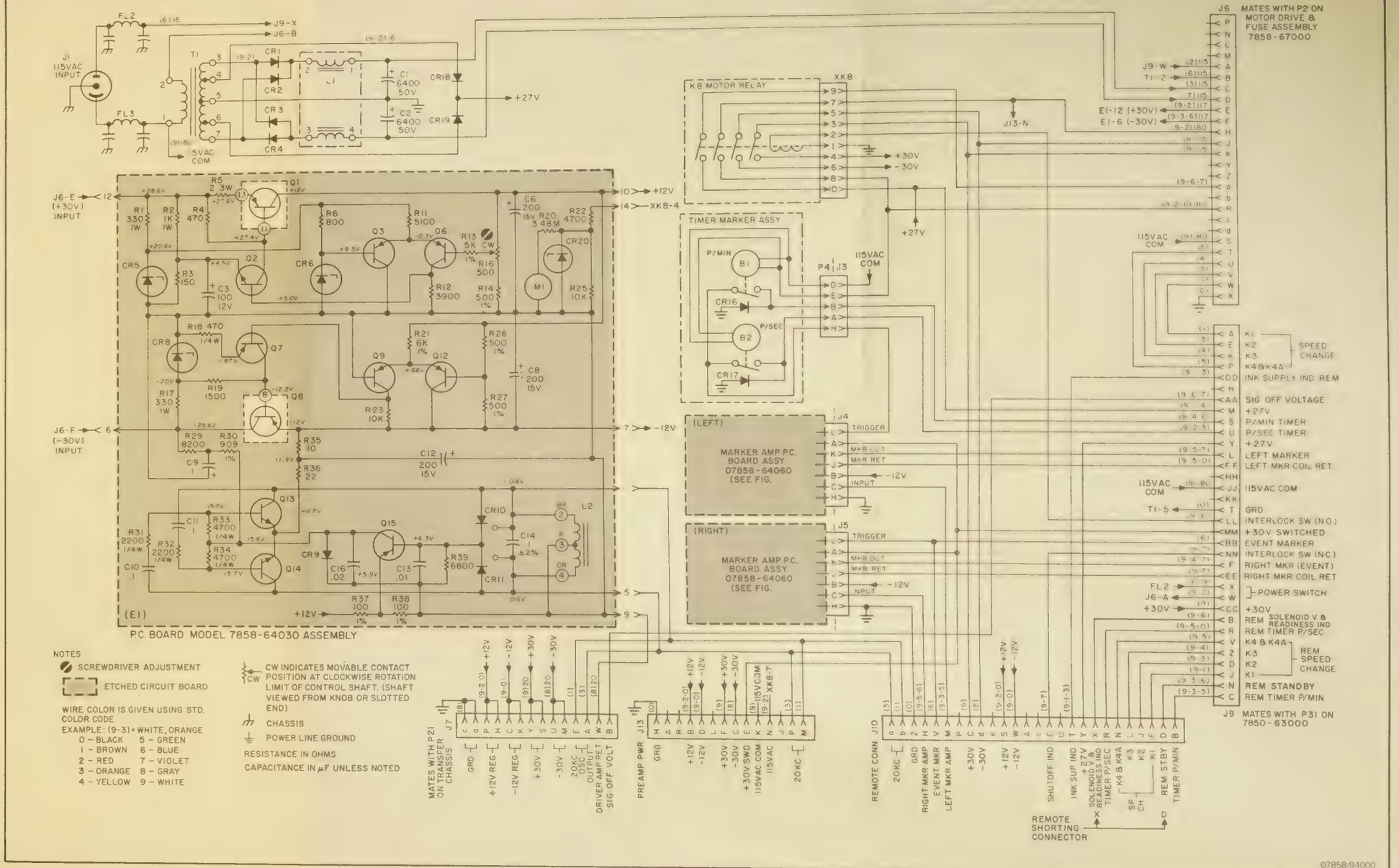


Figure 6A24. Power Supply Schematic for Model 7848A

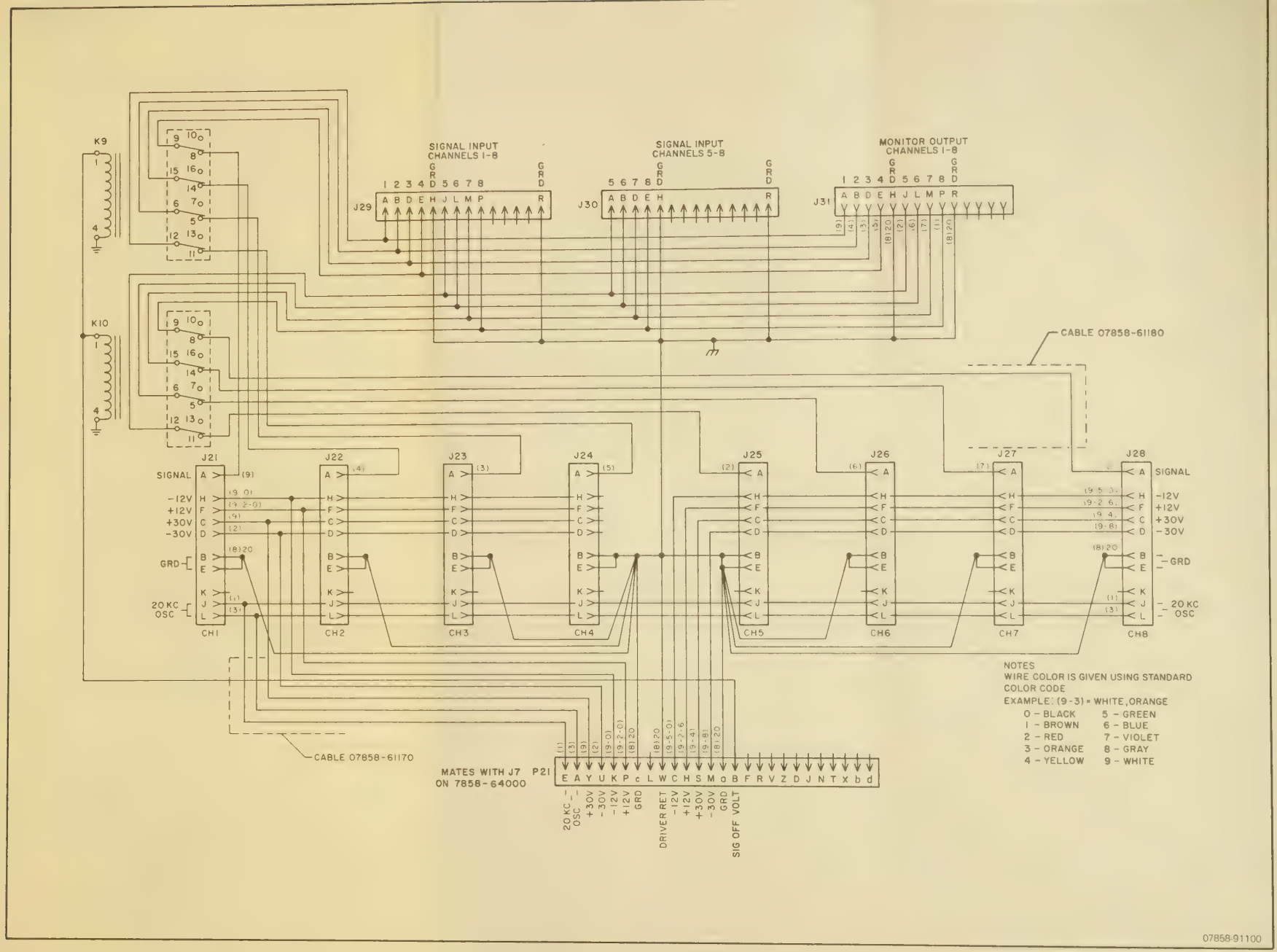


Figure 6A25. Transfer Chassis Schematic for Model 7848A

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Figure 1-1. Hewlett-Packard 7878A Fluid Recording System

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. Purpose and Scope.

1-3. This manual contains operating and maintenance instructions for the Hewlett-Packard Fluid Recording Systems, Models 7858A and 7878A, and is to be used with the Operating and Maintenance Manuals for the specific Preamplifiers ordered and incorporated into the System. Such manuals give detailed instructions for the Preamplifiers and their associated Power Supplies

1-4. Detailed in this manual is information relating to the integration of the system and operating and maintenance information for the cabinet and the Model 7848A Fluid Recorder. The Model 7848A Recorder includes the following major assemblies:

(8) Model 07850-61000 Pen Motors
(8) Model 07850-62000 Driver Amplifiers
(1) Model 07850-63000 Control Panel
(1) Model 07850-64000 Driver Power Supply
(1) Model 07850-67000 Motor and Speed Change

1-5. DESCRIPTION.

1-6. Component Identification.

1-7. The Model 7848A Eight-Channel Fluid Recorder is supplied in the Model 7858A System for use with 8800 Series Preamplifiers and in the Model 7878A System for use with Model 8820A or 8821A Eight-Channel Preamplifier banks (see Figure 1-1).

1-8. Table 1-1, lists the major components which form each System and the options which are available.

1-9. The Recorder Systems.

1-10. Hewlett-Packard Eight-Channel Fluid Recorder Systems are rack-mounted, rectilinear, ink recording instruments designed to measure and permanently record as many as eight input voltages as a function of time. Model 7858A consists of the 7848A Fluid Recorder, the cabinet with its primary power cabling and overload protection, and a power supply for the 8800 Series Preamplifiers, which are ordered separately. Model 7878A consists of the 7848A Fluid Recorder and the cabinet with its primary power cabling and overload protection. One Multi-channel Amplifier, either Model 8820A or 8821A, is ordered separately. System specifications are listed in Table 1-1.

1-11. Model 7848A Recorder.

1-12. The basic unit of the Recording System is the Model 7848A Fluid Recorder. This unit includes the multi-speed chart drive, eight motor-driven pens, eight driver amplifiers, a controlled low pressure ink supply, and a power supply. The eight channels are identical and may be operated from any of the recommended preamplifiers. Specifications for the recorder are listed in Table 1-1.

1-13. Cabinet.

1-14. The Cabinet supports the Recorder on slides for servicing, provides space above the recorder for the preamplifiers, and includes a Power Control Panel. The Cabinet has a foot for stability and rolls on large diameter casters. Specifications are listed in Table 1-1.

1-15. Carrying Case Option.

1-16. When the Recorder System Option 02 is ordered, the Recorder is shipped in one carrying case with its attached Driver Amplifiers and Power Supply. The Preamplifiers and multi-channel Power Supply are in a second case. Under this option, primary power control is provided for each case. Carrying case dimensions are listed in Table 1-1.

1-17. Preamplifier Power Supplies.

1-18. The Model 7858A Recorder System, for operation with 8800 Series Preamplifiers is supplied with a single Preamplifier Power Supply (Model 8800-03A) which provides mounting, power, and signal connections for up to eight Series 8800 signal conditioners.

1-19. The Model 7878A Recorder System does not require a preamplifier power supply, since this item is integral to the Eight-Channel Preamplifier Banks specified for this System.

1-20. FEATURES AND APPLICATIONS.

1-21. Recorder Features.

1-22. The Recorder is a versatile, easily operated device. It writes highly defined and legible traces over its wide spectrum range of dc to 60 Hz for full scale deflections and up to 160 Hz with deflections of 10 divisions.

1-23. Recorder Pens are activated by Pen Motors having core magnets and soft iron outer structures for abundant power, linearity, and valuable shielding. These motors are driven by solid-state amplifiers

Table 1-1. Fluid-Recorder Specifications

SYSTEM IDENTIFICATION

UNIT	EIGHT-CHANNEL SYSTEM	
	7858A	7878A
Fluid Recorder including Driver Amplifiers and Power Supply	7848A (1)*	7848A (1)
Cabinet	07858 (1)	07878 (1)
Preamplifier Power Supply	8800-03A (1)	-----
Preamplifier Rack	-----	-----
Preamplifiers required but not included	8800 Series (up to 8)	8820A or 8821A (1)
Options Available	01, 02, 08, 09	01, 02, 08, 09

* Numerals in parenthesis indicate quantity per system.

System Options:

01 omits cabinet and short power cord and adds:
8120-1007 Power Cord, long.

02 omits cabinet, folded paper table assembly, and short power cord and adds:
8120-1007 Power Cord, long.
07858-69010 Carrying Case

08 permits operation from 50 Hz lines. (Gear changes correct time base)

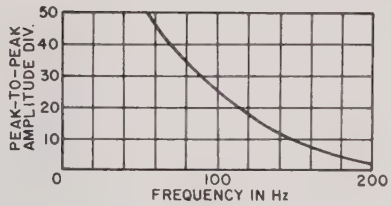
09 adds transformer for 230 V operation.

SYSTEM SPECIFICATIONS

Frequency response:

DC to less than 3 dB down at 160 Hz for chart deflection of 10 div. pp. Typical - 3 dB point for 50 division deflection in 80 Hz. Damping set for 1 div. (4%) overshoot when recording 25 div. pp 10 Hz square wave.

Maximum amplitude/frequency curve:



Paper Speed:

14 speeds selected by seven push-button switches in conjunction with X1 and X100 pushbuttons. A REMOTE pushbutton transfers drive speed, OFF-ON, and MARKER controls to a remote station and also provides a voltage which can be used to indicate readiness remotely. Speeds are: .025, .05, .10, .25, .50, 1.0, 2.0, 2.5, 5, 10, 25, 50, 100 and 200 mm/sec. Speed regulation ±0.5% with 60 Hz line. Paper weave less than .5 division.

Driver Sensitivity:

±2.5 volts nominal, for full recording chart width deflection.

Driver Input Impedance (Preamplifier Loading):

5K ohms, ±5%, single ended.

Noise:

Less than 0.1 divisions pp, with driver input shorted.

Gain Stability (after a one-hour warmup):

Temperature: less than 0.1 div, 20°C to 40°C.
Line voltage: less than ±0.1 div, 115 volts ±10%.

Zero Drift (driver input shorted, and after one hour warmup):

Temperature: less than 0.1 div, 20°C to 40°C.
Line voltage: less than 0.1 div, 115 volts ±10%.

Table 1-1. Fluid-Recorder Specifications (Cont.)

Linearity:

Method 1:
After calibrating for zero error at center scale and +20 divisions, error is less than ±0.25 divisions at any point on printed coordinates (includes hysteresis).

Method 2:
After calibrating for zero error at lower and upper end of printed coordinates, error is less than ±0.5 divisions at any point on scale (includes hysteresis).

Response Time:

With not more than 4% overshoot, time interval between 10% and 90% of final deflection is less than 3 msec (10 div. pp); 4 msec (25 div. pp); 6 msec (50 div. pp).

Limiting:

Electrical, adjustable from 2 mm beyond channel edges to within 12 div. of chart center. Separate positive and negative adjustments.

Markers:

Left edge marker provides 1 sec or 1 min time indication. Right edge marker provides event marking by switch (local or remote), or by applying +1.5 Vdc signal.

Hysteresis:

0.25 div. (included in linearity specification).

Damping:

Pen drive motor simulates a 71% critically damped galvanometer.

Paper:

Eight channels, each 4 cm wide, 50 divisions per channel. Time lines every 1 mm. Suitable for diazo or similar reproduction process.

Roll paper 500 ft x 15-5/8 in.

Z-fold paper 500 sheets folded pack 11-9/10 in x 15-5/8 in.

Paper loading and takeup:

Front panel loading, with internal roll paper takeup, and external Z-fold tray.

Fluid Supply:

Disposable plug-in plastic bottle, 4 oz. contents. Front panel indication of empty bottle.

Trace Width:

Nominal 0.01 in; may broaden to 0.02 inch at lowest chart speeds.

Remote Operation:

Connector provided for remote operation of chart drive, selection of chart speeds, and operation of markers. Drive and time marking circuits operate remotely only when CHART DRIVE, REMOTE button is depressed. Connector also supplies regulated and unregulated voltages and circuits for indicator lights.

Ink System:

Pressurized in relation to the acceleration and velocity of the pen tip. Supply is capable of writing 1000 miles of line. Indicator lights when cartridge is empty. (Recorder continues to run on 30 minute internal reserve.)

Ink:

Ink is permanent, smudge resistant and contact drying with HP ink chart paper.

GENERAL

Power:

115 volts ±10%, 60 Hz, approximately 350 watts (less preamplifiers); see option 08 for 50 Hz operation; see option 09 for 230 volt operation.

Dimensions:

7858A, 7878A System in cabinet:
72-5/8 in. high x 23-7/8 in. wide x 35-11/16 in. deep.

7848A Recorder only:
19 in. wide x 17 1/2 in. high x 20-3/4 in. front-to-back. 445 x 483 x 527 mm). Projects 2-1/4 in. (61 mm) in front of rack.

Option 02 Carrying Cases:

Recorder Carrying Case:

23 in. high x 20-1/4 in. wide x 21-1/4 in. front-to-back (584 x 514 x 536 mm).

8800 Modular Preamplifier Carrying Case:

7-9/16 in high x 22 in. wide x 21-1/2 in. front-to-back (193 x 559 x 546 mm).

8820A or 8821A Amplifier Carrying Case:

5 in. high x 16-11/16 in. wide x 13-3/4 in. front-to-back (127 x 424, 339 mm).

Table 1-1. Fluid Recorder Specifications (Cont.)

Weight:

7858A, 7878A System:

Varies with equipment ordered. Typically about 550 lbs (250 kg) in cabinet; 350 carrying cases (Option 02).

7848A Recorder only:

170 lbs (77 kg).

Portability:

Cabinet:
Four large casters.

Carrying Cases:
Four carrying handles.

Environment:

Cooling:
(7858A and 7878A Systems) Cabinet vented top and bottom for convection cooling. Maximum ambient 40°C vents open; 25°C vents sealed.

Other:
Location should be reasonably free from dust, corrosive or explosive vapors, or extreme cold.

Fuses:

A circuit breaker is provided for each Pen Motor. Fuses for the line, Power Supply and chart drive motor are accessible when the recorder is extended.

Mounting:

Recorder is mounted on slide assembly; locks in closed and extended positions.

Table 1-1. Preamplifier/Model 7858A
Recorder System Specifications (Cont'd)

PREAMP. TYPE	OUTPUT LINEARITY (LESS TRACE WIDTH)	OUTPUT NOISE, MAXIMUM (LESS TRACE WIDTH)	OUTPUT FREQUENCY RESPONSE (10 DIV, DC TO LESS THAN 3dB DOWN AT:)	RISE TIME (10 DIV, 10-90% 4% OVERSHOOT)	GAIN STABILITY 20 to 40 C, 103 to 127V	ZERO DRIFT 20 to 40 C, 103 to 127 Volts LESS TRACE WIDTH
8801A LOW GAIN DC	0.25 div, after calibrating for zero error at center scale and +20 divisions	0.2 div, pp	160 Hz	3 msec	Temperature: 0.2% 10°C Line Voltage: 0.25%	Temperature: 1.25 div 10°C, 0.5 div 8 hr, constant ambient Line Voltage: 0.15 div
8802A MED. GAIN DC	0.25 div, after calibrating for zero error at center scale and +20 divisions	0.2 div, pp	160 Hz	3 msec	Temperature: 0.2% 10°C Line Voltage: 0.25%	Temperature 1.25 div 10°C, 0.5 div 8 hr, constant ambient Line Voltage: 0.15 div
8803A HIGH GAIN DC	1mV range 0.35 div, other ranges 0.25 div, after calibrating for zero error at center scale and +20 divisions	1 div, pp maximum gain 0.1 div, pp minimum gain	> 100 Hz	Approx 5.5 msec	Temperature: 0.2% 10°C Line Voltage: 0.4%, 1mV div to 5mV div; 0.2% other ranges	Temperature: μV range: 1μV 10°C referred to input, ±0.06 div 10°C for 0 output and ±0.45 div/10°C for full scale output mV range: 1mV 10°C referred to input, ±0.06 div 10°C for 0 output and ±0.045 div 10°C for full scale output Line Voltage: 0 output: 0.07 div; full scale output: 0.35 div
8805A CARRIER	0.4 div, after calibrating for zero error at center scale and +20 divisions	0.2 div, pp +1% of chart deflection	> 110 Hz	Approx 4 msec	Temperature: 0.3% 10°C Line Voltage: 0.4%	Temperature: 0.25 div/10°C Line Voltage: 0.25 div
8806B PHASE SENS. DEMOD.	0.4 div, after calibrating for zero error at center scale and +20 divisions	7μV x square root of combined 8806B/recorder frequency response, referred to input	12 Hz (60 Hz reference) 71 Hz (400 Hz reference) 160 Hz (5k Hz reference) OR: $\frac{1}{\sqrt{\left(\frac{5}{\text{ref. freq.}}\right)^2+\left(\frac{1}{160}\right)^2}}$ Hz using fixed-frequency plug-ins	50 msec (60 Hz reference) 8 msec (400 Hz reference) 3 msec (5 k Hz reference) OR: $\sqrt{\left(\frac{3}{\text{ref. freq.}}\right)^2+(.003)^2}$ sec using fixed-frequency plug-ins.	Temperature: 0.35% 10°C Line Voltage: 0.25%	Temperature: 0.3 div 10°C Line Voltage: 0.25 div
8807A AC-DC CONV.	0.55 div + 0.05 div x scale expansion, 330 Hz to 5kHz; Option 01: 60Hz to 5kHz, after calibrating for zero error at lower and upper ends of printed coordinates	Baseline offset and/or noise: 2mV rms referred to input + 0.025 div x scale expansion	54 Hz Option 01: 9 Hz	11.2 msec Option 01: 70 msec Approx 10% overshoot	Temperature: 0.2% 10°C x scale expansion + 0.3% 10°C Line Voltage: 0.24% x scale expansion + 0.4%	Temperature: 3mV/10°C x scale expansion +0.15 div 10°C; at constant ambient 0.5 mV hr referred to input Line Voltage: 0.005 div x scale expansion + 0.1 div
8808A LOG LEVEL	DEPARTURE FROM LOG CHARACTERISTIC 50dB: 1.25 div, 100dB: 1 div, after calibrating for zero error at lower and upper ends of printed coordinates	50 dB range: 0.8 div, pp 100 dB range: 0.4 div, pp (max noise at bottom of recording chart)	Does not apply	Fast: 20.5 msec (.875 dB/sec) Slow: 2 sec (.9 dB/sec)	Temperature 50dB range: 2.05dB, 10°C 100dB range: 2.1dB 10°C Line Voltage 50dB range: 0.58dB 100dB range: 0.65dB maximum gain at bottom of recording chart)	Does not apply. With input shorted output is off scale on bottom of chart.
8809A SIGNAL COUPLER	0.4 div, after calibrating for zero error at center scale and +20 divisions	0.1 div	160 Hz	3 msec	Temperature: 0.6% 10°C Line Voltage: 0.65%	Temperature: 0.2 div/10°C at 30mV sensitivity Line Voltage: 0.3 div

using contactless position feedback from a point close to the pen tip; the system corrects any minor non-linearity in Pen frame and linkage as well as in motors and amplifiers. The writing fluid is delivered at one of three low pressures selected with the chart speeds and modulated for individual Pen writing speeds. It automatically responds to changing waveforms. This fluid system closely maintains the writing line width and permits the use of Z-fold paper. The writing fluid is an especially formulated ink matched to the paper for extremely rapid drying and gap-free traces. There is a low ink supply indicator on the control panel.

1-24. A left edge marker pen provides one second or one minute indications. A right edge marker pen is also supplied and operates by push button or remote signal to mark events.

1-25. Hewlett-Packard ink chart paper, either roll or Z-fold, is 15-5/8 inches wide. The chart moves from top to bottom through a 10-inch viewing area slanted 12° from the vertical. Remaining footage or sections of Z-fold are marked on the chart. The internal paper supply is loaded from the front of the cabinet. Internal paper take-up and a table attachment for external, ready reference, take-up of Z-fold chart paper are standard. Chart paper speeds are push-button controlled for fourteen values ranging from 0.025 to 200 millimeters per second. The chart speed may be programmed remotely.

1-26. Driver Amplifier Features.

1-27. One Driver Amplifier is provided for each recording Pen Motor (see Figure 1-3). The eight Driver Amplifiers are plugged into the transfer chassis connecting them to the power supply which is mounted below the Amplifier section. The combination of Driver Amplifier and Pen Motor simulate the characteristics of a simple galvanometer at 71% damping. Driver Amplifier and Pen Motor characteristics are included in the specifications for the recorder.

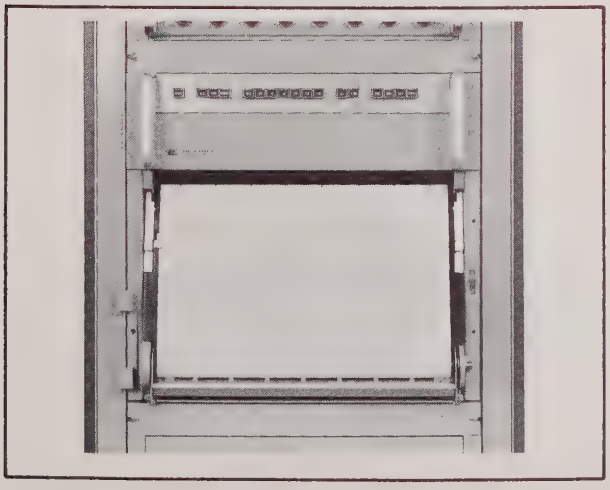


Figure 1-2. 7848A Fluid Recorder

1-28. Driver Amplifier and Recorder Power Supply.

1-29. The 7858-04A Power Supply provides operating power for up to eight Driver Amplifier modules (see Figure 1-4). Unregulated and regulated voltages are also supplied for all recorder functions, i.e., ink supply system, chart drive motor, timers and markers.

1-30. Preamplifier Features.

1-31. The Model 7858A Fluid Recorder System is factory assembled for use with 8800 Series Preamplifiers. These are solid-state signal conditioners available for a variety of applications. They plug in and can be removed and replaced from the front of the cabinet. Signal connections are made at the rear, but outputs can be monitored from the front. Applications for each model Preamplifier are discussed in the related manual.

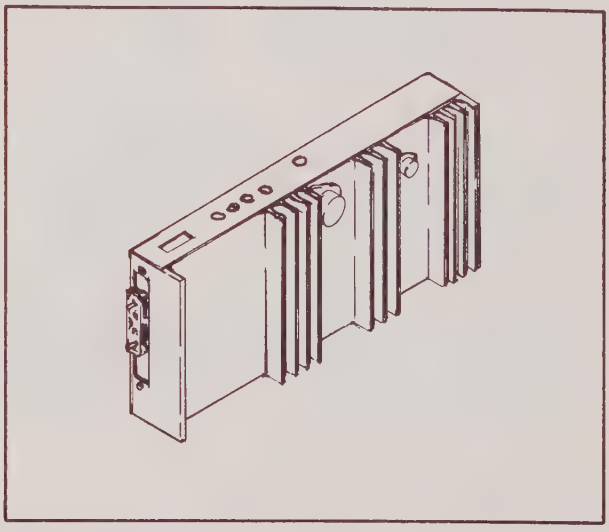


Figure 1-3. 07850-62000 Driver Amplifier

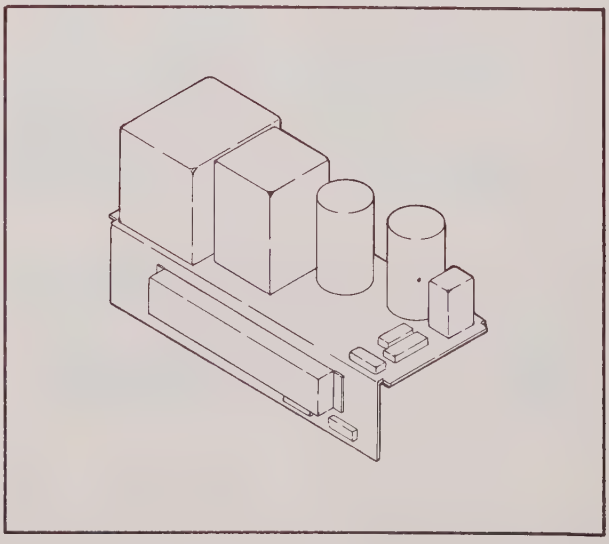


Figure 1-4. 7858-04A Driver Power Supply

1-32. The 7878A System uses an Eight-Channel Preamplifier Bank, either the 8820A low gain Bank or the 8821A medium gain Bank. Amplifiers in these Banks are all-silicon solid-state design. A power supply is integral with each Eight-Channel Preamplifier Bank.

1-33. Preamplifier Power Supply Features.

1-34. For the 8800 Series Preamplifiers, a single Model 8800-03A Power Supply, Figure 1-5, provides operating power for up to eight Preamplifiers, serves as a transfer chassis for signal input and output circuits, and provides mounting facilities for holding the Preamplifiers in place. The basic model of Power Supply provides 440 Hz and 2400 Hz reference or excitation voltages for preamplifier use. Optional versions are as follows:

01: Less 2400 Hz card
02: Less 440 Hz card
03: 40 kHz card substituted for 2400 Hz card

1-35. The 440 Hz voltage is used for the High Gain Preamplifier Model 8803A or for a modified Carrier Preamplifier Model 8805A. The 40 kHz voltage is used for the Floating Input-Floating Output Amplifier, Model 860-4000, not typically included in this System.

1-36. The 7878A System uses an 8820A or an 8821A Eight-Channel Preamplifier Bank, each of which has an integral power supply. In this case, no additional Preamplifier Power Supply is required. Specifications for the integral power supply will be found in the Preamplifier Manual.

1-37. Cabinet Features.

1-38. The Cabinet is expressly designed to provide a safe weight distribution whether the Recorder is in the operating position or extended forward on the heavy duty slides. Space above the Recorder control panel accommodates eight channels of any of the recommended Preamplifiers with specified Power Supplies. The Cabinet is wired for all required primary power. A panel at the top provides an ON-OFF control, power-on indicator, and circuit breaker protection. A full length rear door provides access for input signal connections and servicing.

1-39. The 7858A System Cabinet 0758-69000 has mounting facilities and cables for the 8800-03A Preamplifier Power Supply. The 8800 Series Preamplifiers mount on the front of the Power Supply. The 7878A System Cabinet 07878-69000 has mounting facilities and cables for the 8820A or 8821A Eight-Channel Preamplifier Bank.

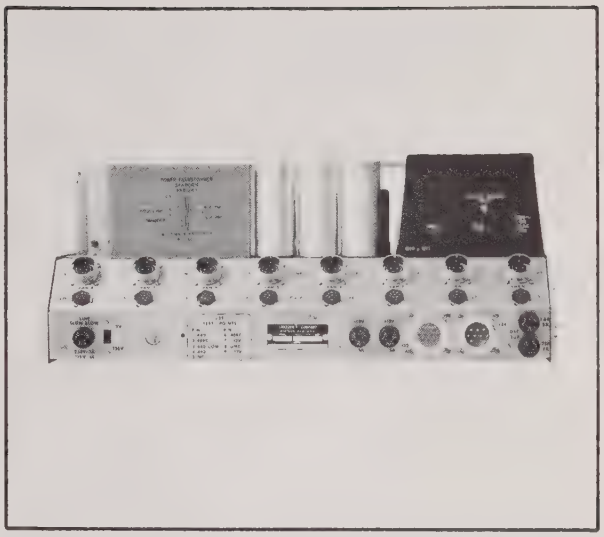


Figure 1-5. 8800-03A Preamplifier Power Supply

1-40. Applications.

1-41. The Eight-Channel Fluid-Writing Recorder System is used for making simultaneous, synchronous recordings of up to eight phenomena with inputs from such varied sources as physiological voltages, thermocouple voltages, and sound sensor outputs. A list of typical applications is given below. Measurements can be made of signals with frequencies varying from dc to 160 Hz, with full scale deflections up to 60 Hz.

Medical
- Operating Room Installations
- Intensive Care Installations
- Physiological Monitoring -- Space Programs, Research
- Multiple ECG Measurements
- Respiration and Heart Rates

Industrial
- General Laboratory Testing
- Process Control
- Telemetry and Computer Output
- pH Measurements
- Frequency Measurements
- Logarithmic Measurements
- Servo Outputs

1-42. ACCESSORIES.

1-43. Preamplifier accessories are listed in the related Preamplifier Instruction Manual. Other accessories shipped with the Fluid Recorder System, or optionally available, are listed in Table 1-2.

Table 1-2. System Accessories

Qty.	Part Number	Description
1	07850-61400	Kit, Stylus Replacement
1	07850-61400	Pen Maintenance Kit, Including Replacement Pen
1	14023A	Tester, Pen Pressure
1	5060-4620	Kit, Connector, Monitor 14-Pin
1	5060-4621	Kit, Connector, Remote Cont. 26-Pin
1	17999-09423	Syringe
1	8120-1008	Power Cord, Short
1	9280-0067	Recording Paper, Z Fold
1	PIM-7858A/ 7878A-1 or PIM-7868A-1	Instruction Manual
AS ORDERED ITEMS:		
	07850-61131	Cable Pen Motor to Driver for Trouble Shooting
	9280-0066	Recording Paper, Roll
	9280-0067	Recording Paper, Z Fold
	07858-67060	Ink Cartridge, 4 oz.
	07858-28390	Spool, P. T. U.
	14036-00010	Pickup Resistor Shim
	14036-00020	Spacer Block, Gear Box
	14036-00030	Alignment Rod, Gear Box
	14036-00040	No-Go Shim Gauge
	14036-00050	Gauge, Air Pressure
	14036-00060	Alignment Tool, Mtg. Pl.
	14036-60010	Platen Alignment Fixture
	14036-60020	Pen Motor Casting & Platen Alignment Fixture
	14036-60030	Pen Profile Fixture
	14036-60040	Tail Pivot & Crank Alignment Fixture

NOTES

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information on unpacking, inspection, repacking, and installation.

2-3. INITIAL INSPECTION.

2-4. Opening the Shipping Container.

2-5. If external damage to the shipping container is evident, ask the carrier's agent to be present when the System is unpacked.

2-6. When assembled in a Cabinet the System is shipped with the Cabinet lying on its back on a skid. Proceed as follows to unpack:

a. On the two long sides, pry out all the staples holding on the hardboard (plywood is used here for export shipments). Remove hardboard (or plywood).

b. Remove end cleats; then remove end hardboard (or plywood) as above.

c. Loosen straps at the buckles. Pull straps off each end.

d. Pry out from the bottom each of the six side supports.

e. Holding the container sides out away from the Cabinet, lift the top and side support assembly up off the System Cabinet.

f. Lift the System Cabinet to the upright position.

2-7. Mechanical Inspection.

2-8. Check the System for external damage such as broken controls or connectors, and dents or scratches on the panel surface. If damage is found, refer to Paragraph 2-12 for recommended claim procedure and repacking information. If the shipping container is not damaged, check the cushioning material and note any signs of severe stress as an indication of rough handling in transit. Retain the packaging material for possible future use.

2-9. Electrical Check.

2-10. Check the electrical performance of the System as soon as possible after receipt; see Section V for the recommended performance checks. These checks will verify that the System is operating within the specifications listed in Table 1-1. They constitute a good test procedure for incoming quality control inspection and for an operational check after repairs or adjustments have been made. For a quick test to reveal damage in transit, see Paragraph 2-45, Initial System Check.

2-11. CLAIMS AND REPACKAGING.

2-12. Claims for Damage.

2-13. If physical damage is evident or if the instrument(s) does not meet specifications when received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office (see list in back of this manual). The Sales/Service Office will arrange for repair or replacement of the unit(s) without waiting for settlement of the claim against the carrier.

2-14. If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office, attach a tag showing the owner with the address, instrument model and serial numbers, and the repair required. The original shipping container and packing material may be reusable, but if it is not, contact the Sales/Service Office for information and recommendations of materials to be used.

2-15. If all parts of the original shipping container are in good condition, repack by reversing the procedure in Paragraph 2-4, using 2-1/2 inch nails for refastening the support assembly and roofing nails to attach the hardboard (or plywood). Make sure that all foam polyethylene pads are in place. Refasten the straps before attaching the hardboard (or plywood).

2-16. Environment.

2-17. System location should be reasonably free from vibration, dust, corrosive or explosive vapors or gases, extremes of temperature, humidity, etc. Allow sufficient room at the front for operation with the Recorder section fully extended. With cabinet mounted equipment, allow space at the rear for servicing with the access door open. System installation must allow adequate clearance for exhaust of cooling air, or the maximum ambient temperature must be derated.

2-18. For cabinet mounted equipment, the floor load-rating should exceed 150 pounds (70 kilograms) per square foot. The floor should be level and must supply support for all four wheels of the System. For instruments in carrying cases, the floor load-rating may be somewhat less. Benches must be rigid and able to support approximately 250 pounds (113 kilograms) for the recorder and 44 pounds (20 kilograms) for the preamplifiers.

2-19. Check that the power line voltage, voltage regulation, power capacity, frequency and frequency stability are suitable for the requirements of the System. The time axis accuracy of the recording will be directly dependent upon the frequency of the power line.

2-20. Recorder Shipping Data.

2-21. The Recorder is firmly held in the Cabinet with shipping screws. These retainers should be released before use. Prepare the Recorder for operation using the following procedures, referring to Figures 2-1 and 2-2 for location of shipping screws.

a. Open the rear access door, locate and remove two shipping screws which hold the Recorder to the Cabinet shipping bracket. Remove and store the bracket.

b. At the Cabinet front, remove the three shipping screws which hold the Recorder to the Cabinet front.

c. Remove the protective tape from the viewing window.

d. Reverse the above procedures to prepare the Recorder for reshipment or storage.

2-22. If the System is shipped without a Cabinet (System Option 01), see Figures 2-3 and 2-4 when mounting the system components in a customer supplied cabinet. All front panel dimensions are referenced to the top of the individual panel.

2-23. If the System is shipped in portable cases (System Option 02), remove protective tape from viewing window.

2-24. Preamplifier Installation.

2-25. The Recording System is shipped complete with all Preamplifiers in place with the proper model of Preamplifier Power Supply for the Preamplifiers ordered.

2-26. The various models of Preamplifier have different excitation voltages and different input-signal cabling requirements as shown in Table 2-1.

2-27. Options of Preamplifier Power Supply for the 8800 Series provide different excitation voltages as indicated in the Power Supply specifications listed in Paragraph 1-33, Preamplifier Power Supply Features. The basic unit, Model 8800-03A, is converted by the selection of oscillator cards which are plugged into the Power Supply.

Table 2-1. 8800 Series Preamplifier Requirements

Model	Excitation	Signal Cable
8801A	none	unguarded
8802A	none	unguarded
8803A	440 Hz	guarded
8805A	2400 Hz	unguarded
8806A	none	guarded
8807A	none	guarded
8808A	none	unguarded
8809A	none	unguarded

Note: Preamplifiers (excepting 8809A) with unguarded input circuit will operate normally with a guarded input circuit cable.

2-28. Remove and replace Modular Preamplifiers with the following procedure:

CAUTION

DISCONNECT SYSTEM POWER BEFORE REMOVING OR INSTALLING ANY MODULE.

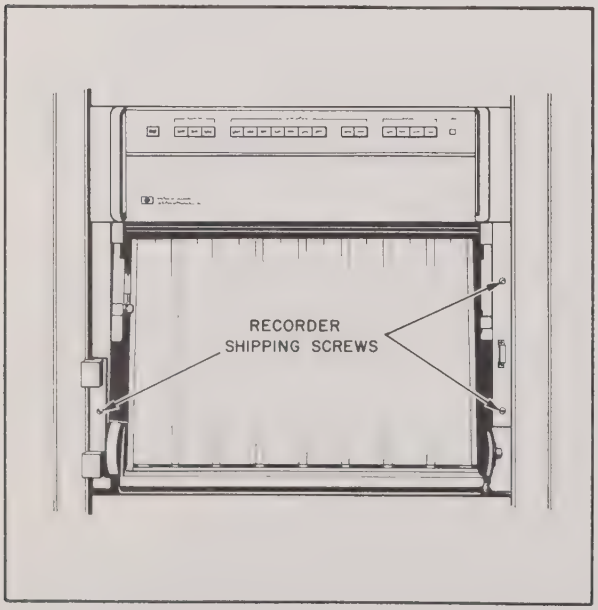


Figure 2-1. Cabinet-Front View

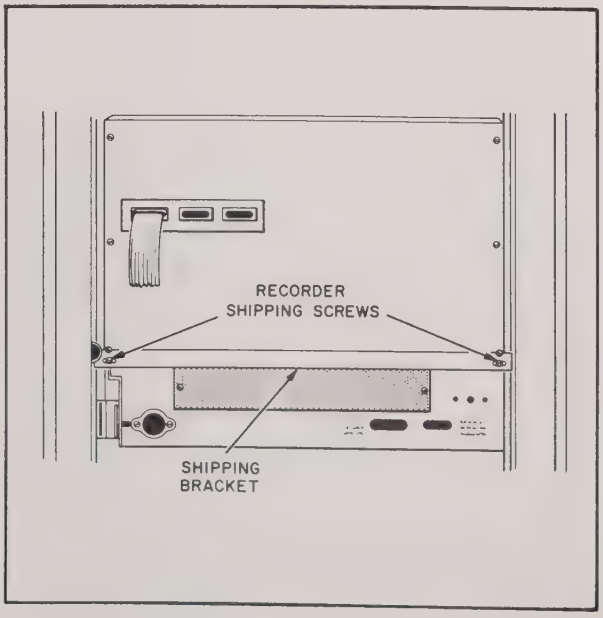


Figure 2-2. Cabinet-Rear View

a. Loosen the two screws (top and bottom) and pull straight out, using the handle.

b. Check excitation voltage and cabling requirements in Table 2-1 before inserting a replacement 8800 Preamplifier.

c. Slide new Preamplifier into the channel guide, push in firmly to mate with the connector of the Preamplifier Power Supply, then tighten the two captive screws.

2-29. To remove Eight-Channel Preamplifier Banks, first disconnect all cables at the rear. Then remove two screws at each side of the front and pull out the unit on its slides.

2-30. Power Connections.

2-31. Check that the power line voltage and frequency are the same as shown on the Recorder nameplate. The nameplate is located at the top front corner of the right side of the Recorder chassis. To read the nameplate, move the Recorder out of the chassis on its slides. Two latches will be found, one under each piece of vertical trim on the viewing door. See Figure 3-2, Item 9. Press latches toward outside of Cabinet while pulling Recorder out.

2-32. Set the 115/230 volt selector switch on the rear of the Preamplifier Power Supply to 115 volts. (Systems assembled for 230 volts input power use a 230 volt to 115 volt stepdown transformer to power the entire system.)

2-33. Connect the System to an approved power source, preferably to a three-wire polarized outlet. If only a two-wire service is available, use the three-wire to two-wire adapter (supplied as an accessory) between the system power cord and the line outlet. Connect the ground wire of the adapter to an electrical ground such as a water pipe.

2-34. Internally, the Preamplifier Power Supply and the Recorder are connected to the line power at the ac power strip along the left side of the cabinet (rear view).

2-35. Signal Connections.

2-36. Prepare signal cables and connectors as described in the Preamplifier Manuals. All input connectors are mounted on the rear panel of the Preamplifier Power Supply (7858A) or Preamplifier Chassis (7878A). Preamplifier connections are shown in Figure 2-5 for the 7858A System and in Figure 2-6 for the 7878A System. Recorder signal connections are shown in Figure 2-7.

2-37. Unguarded input circuits normally use a single-shielded, two-conductor microphone cable, with the shield grounded. A double-shielding cable may be used instead by connecting the two shields together.

2-38. Guarded input circuits commonly use a single-shielded, two-conductor microphone cable, with the shield connected as guard. In case of signal coupling from the common mode voltage on the shield, a double-shielded cable may be used, with the inner shield as guard and the outer shield grounded.

2-39. Single-conductor cable may be used with single-ended inputs by connecting the grounded shield as the signal ground conductor.

2-40. Signal cables are connected into the system through the hole at the bottom right rear of the cabinet on the panel below the access door. Remove the plate covering the hole for access.

2-41. Special Connections.

2-42. Remote control circuits used with connector J10 on the Recorder chassis are shown in Figure 2-8.

2-43. Carrier Preamplifiers, such as the 8805A, require an excitation voltage for the transducer. This is applied to the related output connector (see Figure 2-5) with a two-wire shielded cable and HP connector No. 1251-1708, a Preamplifier Power Supply accessory. For pin connections, see Table 2-2.

2-44. Phase Sensitive Demodulator Preamplifiers such as the 8806A require a reference voltage. This is applied to the related output connector (see Figure 2-5) with a two-wire shielded cable and HP connector No. 1251-1708. For pin connections, see Table 2-2.

Table 2-2. Excitation and Reference Voltage Connections

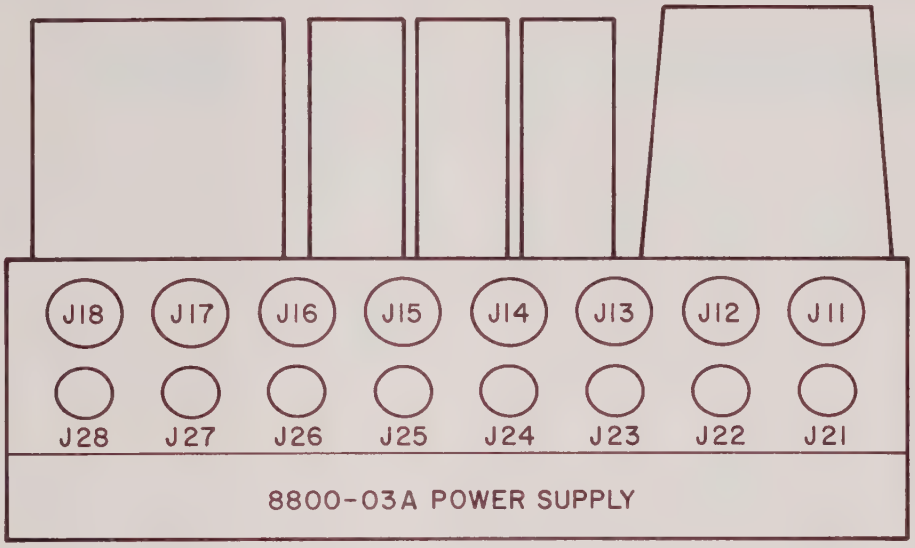
Function	Terminal on J21 through J28 on Preamplifier Power Supply 8800-03A
Excitation + Excitation - Shield, GRD	A B E
Reference Reference Shield, GRD	F K C

Note: Other terminals may be in use at the same time.

2-45. INITIAL SYSTEM CHECK.

2-46. After reviewing the installation process, check all cables and tighten all connectors. See that the power cord is connected.

Figure 2-4. Recorder Installation and Adjustment Data for Use with System Option 01



SIGNAL INPUT CONNECTIONS

Signal inputs to the 7858A Recording System are made at the connectors J11 to J18 located on the rear of the 8800-03A Power Supply. Channel identification is given below.

Input Signal Channel Identification	
Channel	Input Connector
1	J11
2	J12
3	J13
4	J14
5	J15
6	J16
7	J17
8	J18

The signal input cables are fabricated using cable connectors HP No. 1251-1860 supplied as accessories with the recording system. The wiring of the input connectors depends on the Model 8800 Preamplifiers installed in the system. For wiring details see the preamplifier instruction manuals.

8800-03A OUTPUT CONNECTIONS

All 8800 Preamplifier outputs are available at J34 located on the rear panel of the 8800-03A Power Supply. Cable No. 07858-61190 connects between J34 and J9 located on the 7848A Recorder. See Figure 2-7 for cable wiring. In addition, the output of each preamplifier channel is available for monitoring purposes at J21 through J28. Channel identification is given below.

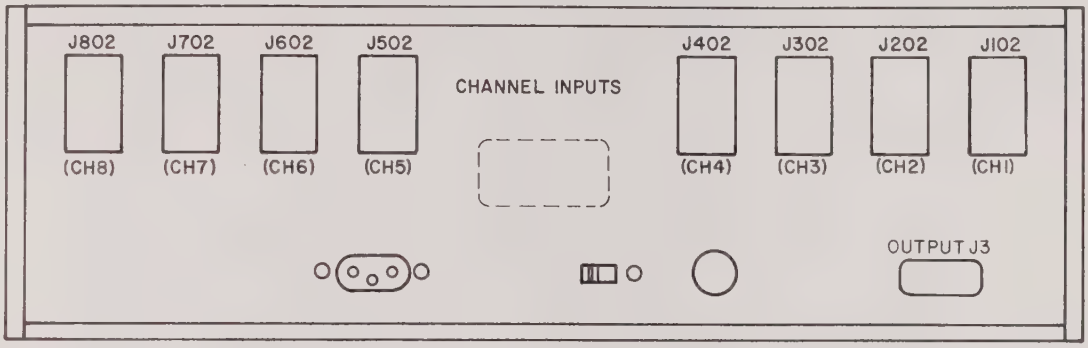
Output Signal Channel Identification	
Channel	Output Connector
1	J21
2	J22
3	J23
4	J24
5	J25
6	J26
7	J27
8	J28

OUTPUT CONNECTOR J21 - J28 WIRING

Function	Terminal
Signal	D
Signal Gnd	C
Shield (opt.)	H

Figure 2-5. Model 7858A Signal Input Connections

Input connectors for the 7878A Recording System are mounted on the rear panel of the 8820A, 8821A Multichannel Amplifiers. Channel identification is shown below.



8820A CONNECTOR WIRING

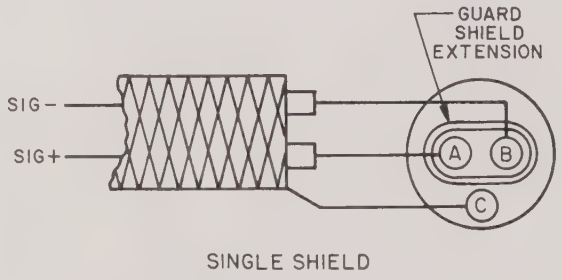
Input connectors HP No. 1251-1245 are supplied as accessories with the 8820A. Connect the input signal to pin 1. Connect the cable shield (ground) to pin 2. Pin 3 is not used.

8821A CONNECTOR WIRING

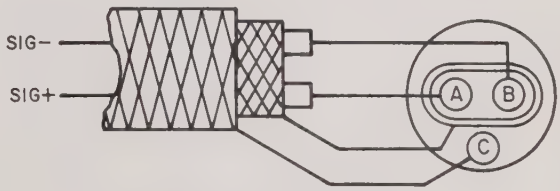
Input connectors HP No. 1251-1860 are supplied as accessories with the 8821A. Connector wiring diagrams are given below.

Non-Guarded Input

For applications where the input cable shield is grounded at the signal source, wire the input connector as shown below.



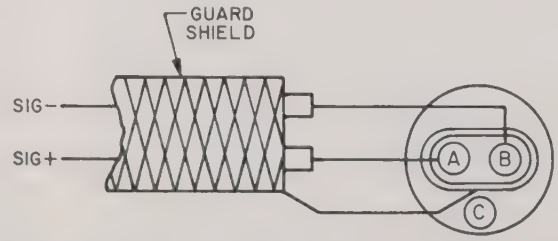
SINGLE SHIELD



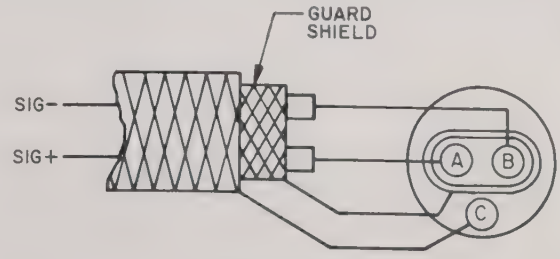
DOUBLE SHIELD

Guarded Input

If guarding is used for the rejection of common mode noise disturbances, wire the signal input connector as shown in the diagram below. The guard shield is connected at the signal source to the signal source common mode potential.

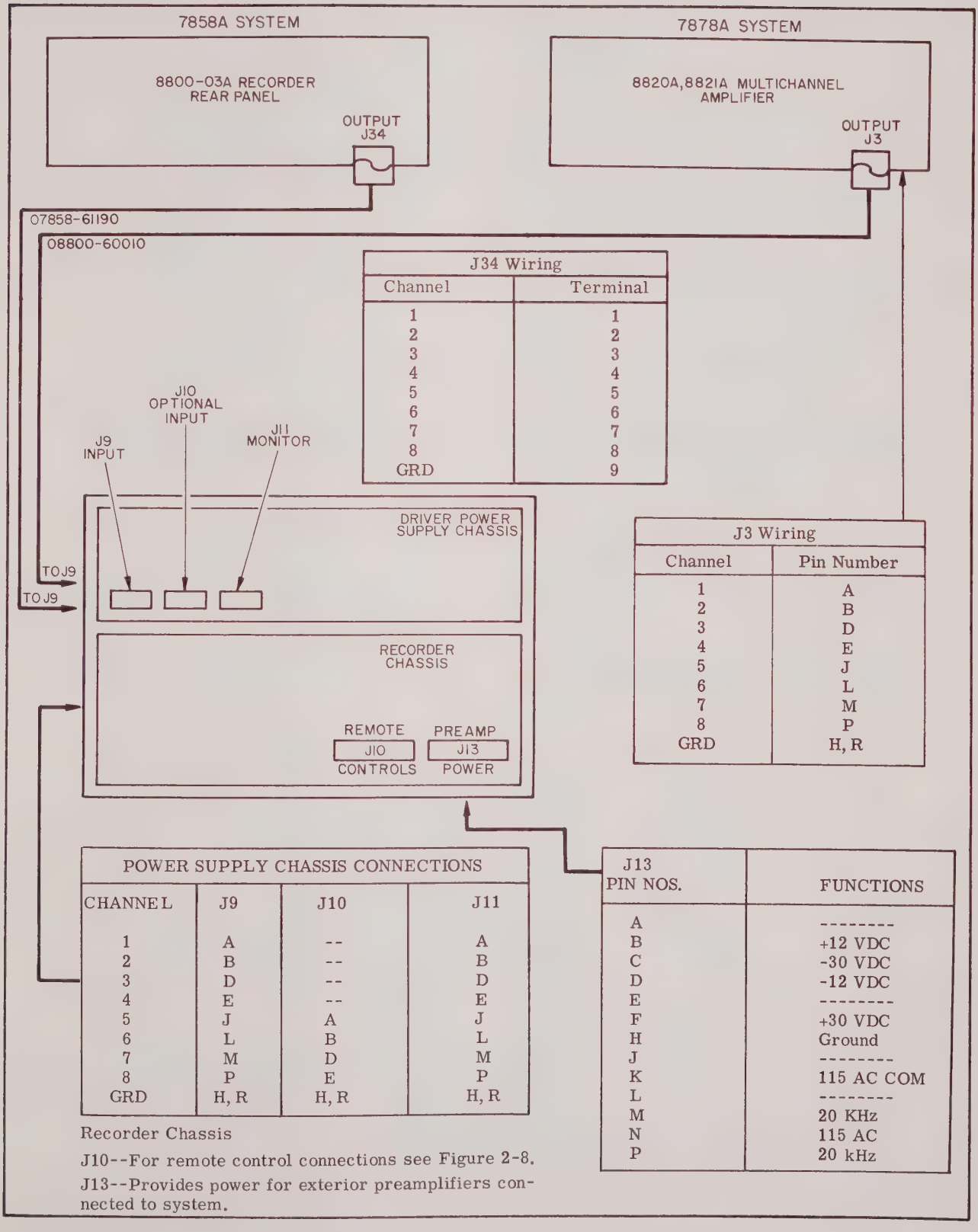


SINGLE SHIELD



DOUBLE SHIELD

Figure 2-6. Model 7878A Signal Input Connections



J34 Wiring	
Channel	Terminal
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
GRD	9

J3 Wiring	
Channel	Pin Number
1	A
2	B
3	D
4	E
5	J
6	L
7	M
8	P
GRD	H, R

POWER SUPPLY CHASSIS CONNECTIONS			
CHANNEL	J9	J10	J11
1	A	--	A
2	B	--	B
3	D	--	D
4	E	--	E
5	J	A	J
6	L	B	L
7	M	D	M
8	P	E	P
GRD	H, R	H, R	H, R

J13 PIN NOS.	FUNCTIONS
A	--------
B	+12 VDC
C	-30 VDC
D	-12 VDC
E	--------
F	+30 VDC
H	Ground
J	--------
K	115 AC COM
L	--------
M	20 KHz
N	115 AC
P	20 kHz

Recorder Chassis

J10--For remote control connections see Figure 2-8.

J13--Provides power for exterior preamplifiers connected to system.

Figure 2-7. Connections to the Recorder and Driver Amplifiers

REMOTE RECORDER CONTROL CIRCUITS

To control the 7858A, 7878A Recording Systems from a remote location, construct the circuits shown, using the connector HP No. 5060-4621, supplied as an accessory.

Attach the remote control circuits to J10, located on the rear panel of the recorder.

A connector with jumper wire from terminals D to X is normally installed in J10, for local control of the recorder functions. To use the remote control circuit, remove and store this connector. Reinstall the connector in J10 when the remote control circuit is disconnected from the recorder.

REMOTE CONTROL OPERATION

To control the recorder from a remote location, press the REMOTE pushbutton on the recorder front panel. To return to local recorder control, set S5 to STANDBY position and press the STANDBY pushbutton on the recorder.

REMOTE CONTROL SWITCH FUNCTIONS

Standby - With S5 closed, the recorder is in standby mode. In standby, signals to the writing pens are interrupted.

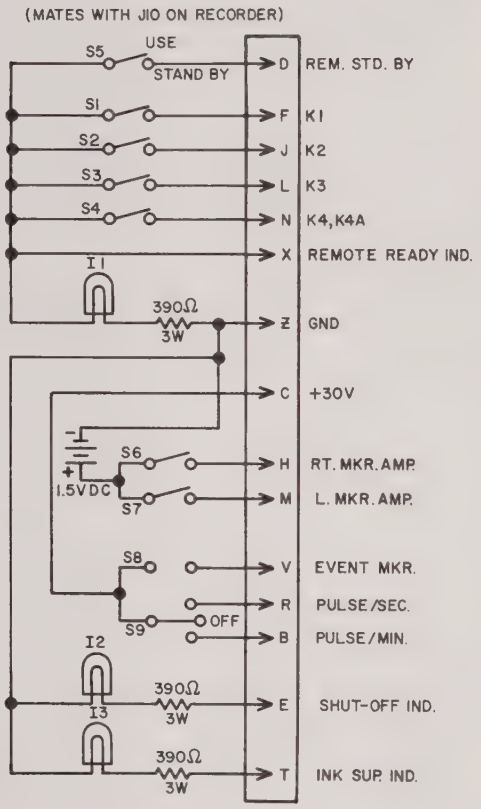
Chart Speed -

Chart Speed mm/sec	Close Switches
0.025	none
0.05	S1
0.10	S2
0.25	S3
0.50	S3, S1
1.0	S3, S2
2.0	S3, S2, S1
2.5	S4
5.0	S4, S1
10.0	S4, S2
25.0	S4, S3
50.0	S4, S3, S1
100.0	S4, S3, S2
200.0	S4, S3, S2, S1

Markers -

Function	Close Switches
Right Marker	S6
Left Marker	S7

External logic circuits can be used instead of S6, S7 to apply +1.5 Vdc to terminals H and M.



EVENT MARKER - Momentary contact switch S8 actuates right edge marker using +30V from recorder power supply.

TIMING MARKER - Three position switch S9 controls timing marker circuit.

Indicator Lamps -

I1 REMOTE READINESS INDICATOR - Lights when recorder is ready to run. If recorder power is OFF or if recorder STANDBY button is pressed, indicator is not lit.

I2 CHART INTERLOCK INDICATOR - Lights when paper supply is used up.

I3 INK SUPPLY INDICATOR - Lights when ink supply is empty.

(Indicator lamp and lens assembly is HP No. 00780-60210.)

Figure 2-8. Remote Control Circuits

2-47. The following procedures are designed to check the Recorder operation and, with the calibration voltage at the various Preamplifiers, to check the major portion of the System electronics. It is assumed that the System has been shipped or stored with a limited supply of roll chart paper to ensure a suitable bearing surface for the pens. Note that the tests outlined here are for quick assessment of the System and are not definitive as to the meeting of specifications. Section V details more exhaustive tests. Refer to Figure 2-9 for the location of the System controls.

a. Remove all signals by turning the GAIN or ATTENUATOR control on each signal conditioner to the minimum signal position. (See individual Preamplifier Instruction Manuals.)

b. Press CHART DRIVE, OFF button.

c. Press .025 chart SPEED and X100 SPEED multiplier buttons.

d. Press the Master Power Switch button at the top of the Cabinet. Button will be back lighted if power is applied.

e. If the chart illuminator is not lighted, press Recorder POWER switch.

f. Press CHART DRIVE, RUN button. Chart paper should run downward. If chart does not run, open door and check that paper table is secure (see Figure 3-4). Press in on the chart paper just above tab on the left to set interlock switch (see Figure 3-3). As chart starts, INK supply light may come on momentarily while pressure builds up.

g. Check paper travel while selecting each speed in turn. Press X1 multiplier button and repeat tests with each speed button. Return to .025, X100 condition.

h. Press SEC, MARKER control. The left edge pen should mark indications every minute. Press EVENT, MARKER control. The right hand pen should move a few millimeters to left and return when button is released. The first time this is operated, the pen may already be at the left. In this case, there will be no movement until button is released. Subsequent operation should be as described.

i. Check position (POS) control at each Preamplifier. With the respective ATTENUATOR (or RANGE) control at OFF, rotate position (POS) control throughout the control range. The corresponding channel stylus should deflect over full channel width on chart. Set each channel to indicate chart center.

j. With input signals still removed, run a few feet of paper at 25 mm/sec. (.25, X100). Inspect the recording for baseline stability. Each baseline should be within one division of midscale.

k. Apply a known test signal to each Preamplifier, or use Preamplifier Calibration Signal to check that the response on the Recorder chart is representative of calibration signal. For this test, set sensitivity and position controls according to the Preamplifier Instruction Manual.

l. Press the Master Power Control button to remove power from System.

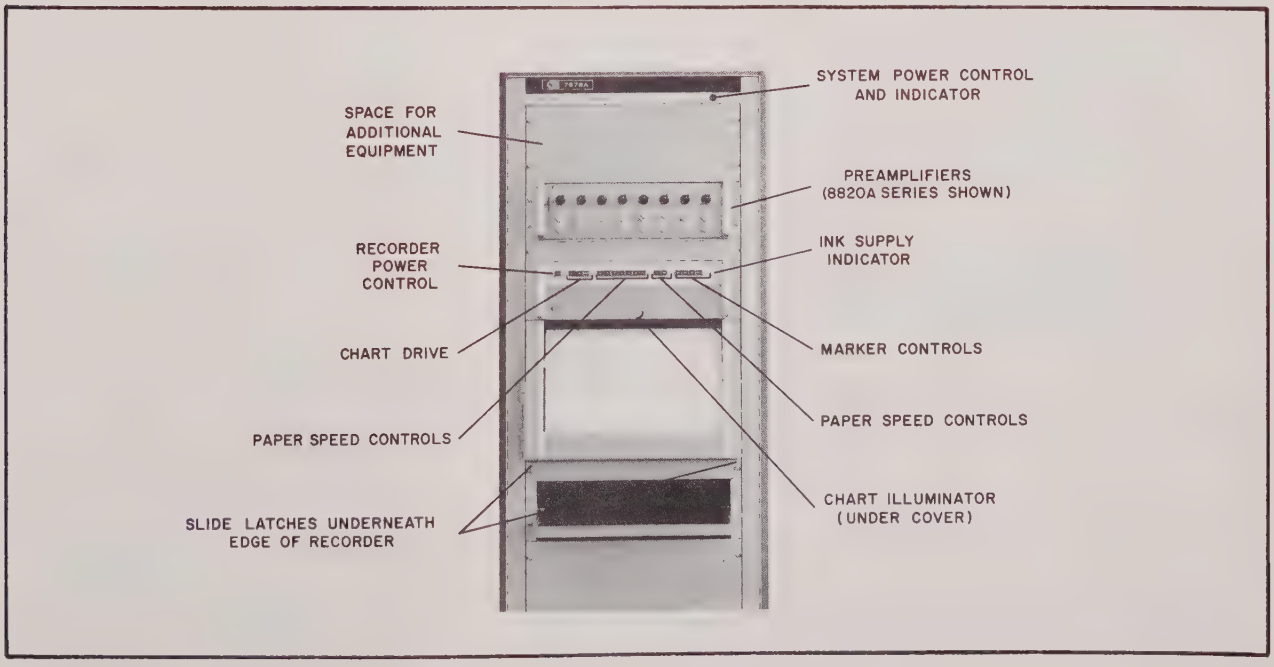


Figure 2-9. System Controls, Model 7858A

NOTES

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. Operating procedures in this section assume that the installation is complete.

3-3. System operation is performed entirely at the front panels of the System. Internal adjustments are typically a part of maintenance and are in Section V. Basically, the major components of the System function as follows:

a. Cabinet; controls power ON-OFF function.

b. Preamplifiers; condition the input signal.

c. Eight-Channel Fluid-Writing; provides permanent readout of the conditioned signals.

3-4. An HP Ink Chart Paper recording can be readily copied since it has a sharply defined trace. Experimentation at the duplicator can improve the quality of the reproduction. A special grade of chart paper (9280-0066 for roll paper, 9280-0067 for Z-fold) is available for applications in which the quality of diazo reproductions is important. This paper has greater transparency with a slight sacrifice in characteristics at elevated temperatures or high humidity. Refer to Table 3-1 for information on the different processes.

3-5. Figure 3-1 shows part of an HP Ink Chart Paper recording, reproduced, using the offset printing method.

3-6. PRELIMINARY OPERATION.

3-7. Pre-Operational Check.

3-8. A System check is recommended at the start of each operation day, and/or prior to a series of measurements. Refer to Paragraph 2-45 in Section II, for Initial System Check. In addition, under special circumstances, such as restoration to service after shut-down for repairs, storage, or shipping, or because high reliability is paramount, or because a long continuous run is about to be undertaken, the 1000 hour preventive maintenance check should be implemented (see Table 5-6).

Table 3-1. Reproduction of Hewlett-Packard Ink Chart Paper

METHOD	QUALITY	RECOMMENDED FOR	REMARKS
Letter press or offset printing	Good to excellent	Large number of high-quality copies	Consult your printer for his requirements on preparation.
Photographic duplicator, direct	Good to excellent	Small number of high-quality copies	Requires handling the recording for each copy made; see two-step process (below) to reduce handling.
Photographic duplicator, two-step	Some loss compared with direct copies	Small number of copies, with minimum handling of original	Make intermediate copy for use as a new original; original handled only once.
Photographic and diazo duplicators	Good	Moderate number of copies using standard engineering laboratory equipment	Make intermediate copy (as above) on film or translucent stock, then pass this copy through diazo duplicator. Original handled only once.
Electrostatic duplicators	Fair to good	Moderate number of copies	----
Thermal duplicators	Poor to fair	Moderate number of copies	----
Diazo duplicators (9280-0080 and 9280-0081 papers)	Fair	Small number of copies	Requires handling the recording for each copy made.
Diazo duplicators (9280-0066 and 9280-0067 papers)	Good	Moderate number of copies	Requires handling the recording for each copy made.

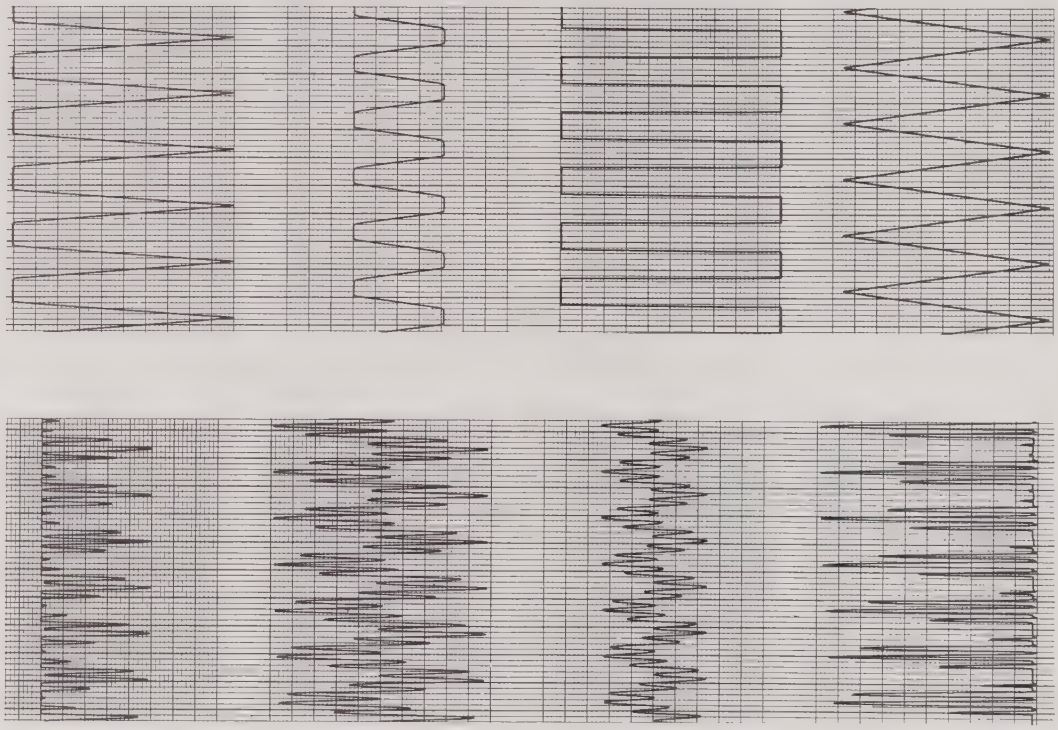


Figure 3-1. Fluid Recording Sample - Offset Printed

3-9. Controls and Functions.

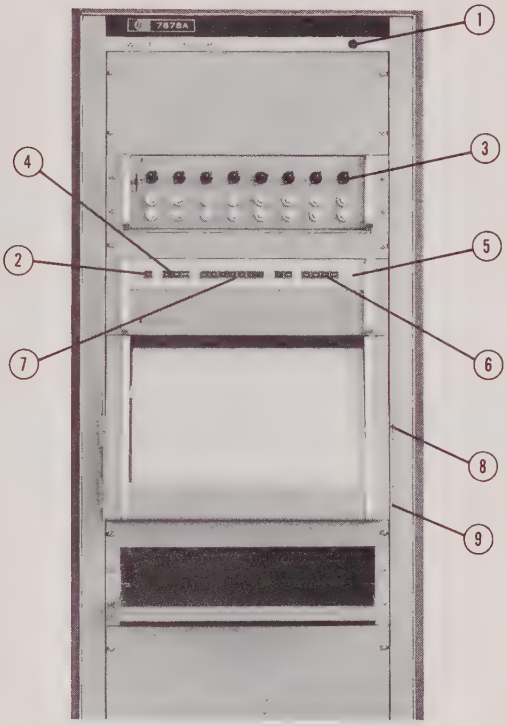
3-10. Refer to Figure 3-2 for location and identification of the System controls, and Figure 3-3 for system operating procedure.

3-11. Paper Loading and Removal.

3-12. Use the step sequences in Figure 3-4 for roll paper loading and removal and Figure 3-5 for Z-fold paper loading. Note that when it is convenient, Z-fold paper can be threaded for internal take-up and roll paper for external accumulations.

3-13. Replacing Ink Cartridge.

3-14. Use the steps illustrated in Figure 3-6 for installing a new ink supply.



1 Master Power Switch: A combined power switch, circuit breaker, and power-on indicator. Press to apply power; press again to remove power. Back lighted when power is on.

2 Recorder POWER Switch: Press to apply power; press again to remove power. Chart illuminator indicates power-on condition.

3 Preamplifiers or Signal Conditioners: Refer to individual instruction manuals for information about the controls.

4 SPEED MM/SEC control buttons: Paper drive speed control provides seven primary speeds from .025 to 2.0 millimeters per second when multiplier is set at X1. Speed button in use stays depressed. Chart Speed Multiplier control buttons allow selection of Primary Chart Speed (X1) or 100 times Primary Chart Speed (X100). Ratio button in use remains depressed.

5 INK Supply Indicator: Lights when ink cartridge is empty. (An internal reserve lasts about 30 minutes.)

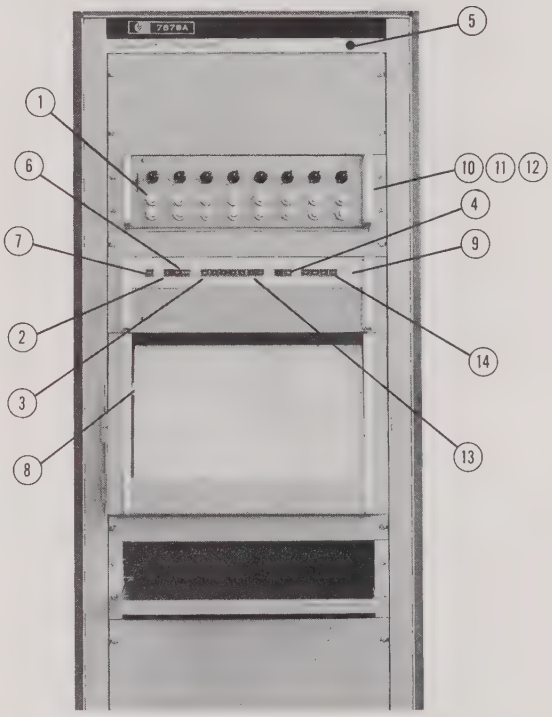
6 MARKER Controls: Push buttons select SEC (marker every second), MIN (marker every minute), or OFF. These produce brief timing marks on left edge of chart. EVENT button causes displacement of right edge marker which returns when button is released.

7 CHART DRIVE Controls: Start (RUN) or stop (OFF) chart drive. REMOTE button transfers Chart Drive and Marker controls to remote station.

8 Door opening lever: Push in toward left to open Recorder door.

9 Slide Latches (beneath Recorder edge): Move toward outside of Cabinet to release; then roll Recorder out.

Figure 3-2. System Controls - Location and Function



1 Remove all signals by turning the GAIN or ATTENUATOR control on each signal conditioner to the minimum signal position. (See the individual Preamplifier Instruction Manuals.)

2 Press CHART DRIVE OFF button.

3 Press the .025 chart SPEED button.

4 Press the X100 chart SPEED multiplier button.

5 Press Master Power Switch at top of cabinet.

6 Press CHART DRIVE RUN button.

7 Press Recorder POWER Switch if chart illuminator is not lighted.

8 If chart does not run, open door and check that paper table is secure. (See Figure 3-4.) Press in on chart paper just above tab on left to set interlock switch.

9 As chart starts, INK supply light is momentarily lighted while pressure builds up.

10 Adjust each Preamplifier POSITION control to set the corresponding stylus at zero reference (channel center).

11 Refer to Preamplifier Instruction Manual and calibrate each Preamplifier.

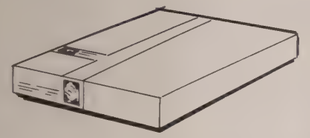
12 Set the Preamplifier Attenuators to least sensitive position. Apply input signals to be monitored. Reset Attenuators as required.

13 Press the SPEED MM/SEC button and the X1 or X100 multiplier button to give chart speed suited to the signals being recorded.

14 Use the EVENT button to identify sections of recording or press SEC or MIN button for periodic marking of the record.

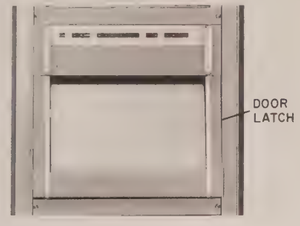
Figure 3-3. System Operation

1. UNPACK PAPER



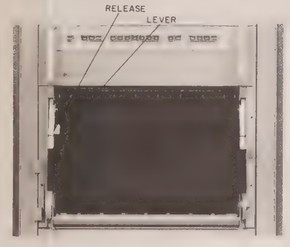
Unpack paper following instructions inside the package.
Remove and discard the top cardboard protector.
Stand paper pack on end to even the paper edges.

2. OPEN RECORDER DOOR



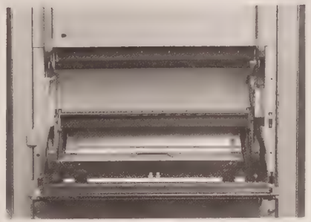
Open recorder by pressing latch on right edge of recorder.
Swing door fully open.

3. UNLOCK PAPER TABLE



Press releases on ends of recorder, unlocking the paper table.
Raise both levers to the fully upward position.

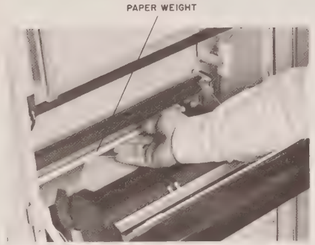
4. LOWER PAPER TABLE



Lower the paper table to the fully downward position.

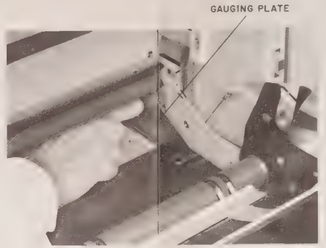
NOTE: Remove roll paper supply spindle and roll paper takeup spindle if they are installed in the recorder, see Figure 3

5. LOCK PAPER WEIGHT



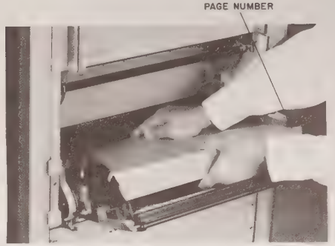
Push the paper weight upward, into the locking position.
Remove any remaining Z-fold paper in the tray.

6. RELEASE GAUGING PLATE



Press gauging plate to the right and rearward until it locks into the released position;

7. LOAD PAPER PACK

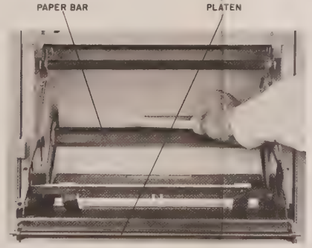


Rest pack on paper table between side plates.
Page number should appear at location shown.

8. PULL GAUGING PLATE KNOB

Slide pack into the recorder as far as it will go, as shown.
Pull the gauging plate knob forward using a firm pressure.
This action positions the pack against the left side plate.

9. THREAD PAPER

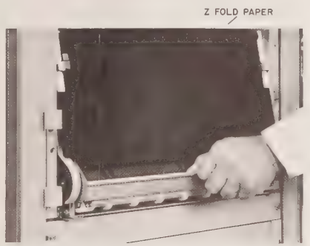


Pull paper bar fully forward and hold in extended position.
With the other hand pick up the front edge of the top sheet and pull it upward, behind the bar.
Release the bar, pull enough paper so that approximately 1½ sheets hang vertically in front of the platen.

10. CLOSE PAPER TABLE

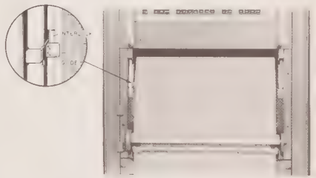
Slowly raise paper table.
Raise side lever to fully upward position, and push table inward until it stops.
Hold free end of paper taut, and with the other hand slowly push one lever downward to locking position.
Push other lever downward to locking position.

11. RELEASE PRESSURE ROLL



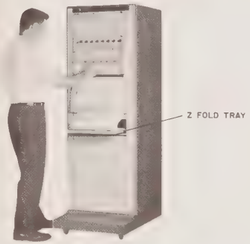
Lift the paper to expose the front of the recorder.
With the other hand push the pressure roll bar INWARD then UPWARD,releasing the pressure roll.

12. THREAD PAPER BEHIND PRESSURE ROLL



Thread paper downward, behind the pressure rollers as shown.
Pull until a few inches of paper extend downward.
Press interlock while positioning paper over interlock and under the guide.
The recorder runs only if the interlock switch is held in by the recording paper.
Lower the pressure roll bar until it locks.

13. TO USE Z FOLD TRAY



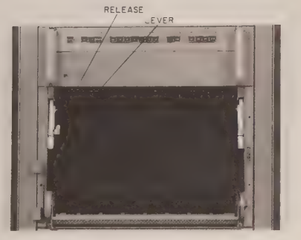
Push in bottom of tray panel and pull out Z fold tray fully.
For correct folding of paper on tray, first sheet must be odd numbered.
If even numbered page appears first, cut off one page.

Figure 3-4. Z-Fold Paper Loading Procedure

1. OPEN RECORDER

Open recorder by pressing latch on right edge of recorder.
Swing door fully open.

2. UNLOCK PAPER TABLE

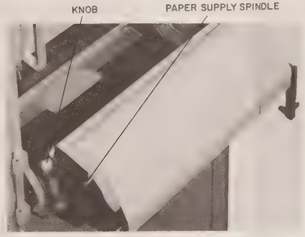


Press releases on ends of recorder, unlocking the paper table.
Raise both levers to the fully upward position.

3. LOWER PAPER TABLE

Lower the paper table to the fully downward position.

4. REMOVE REMAINING PAPER

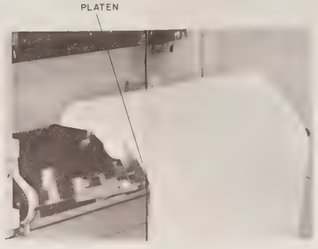


To release paper supply spindle press in both ends.
To release takeup spindle pull knob on left end.
Remaining Z-fold paper supply can be left in recorder.

5. INSTALL SUPPLY SPINDLE IN NEW PAPER ROLL

Push spindle into paper roll.
Spindle ends should be free to move in paper core, and should not bind.

6. PLACE PAPER ROLL IN MOUNTING BRACKETS



Press in both spindle ends and lower paper roll into brackets.
Check that both ends are locked in place.
Pull about 20 inches of paper over platen, as shown.

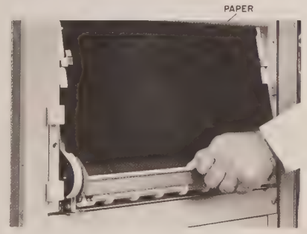
FOR USE WITHOUT INTERNAL PAPER TAKE UP PROCEED TO STEPS 7,8,9

FOR USE WITH INTERNAL PAPER TAKE UP OMIT STEPS 7,8,9

7. CLOSE PAPER TABLE

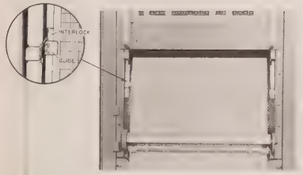
Slowly raise paper table.
Raise side lever to fully upward position, and push table inward until it stops.
Hold free end of paper taut, and with the other hand slowly push one lever downward to locking position.
Push other lever downward to locking position.

8. RELEASE PRESSURE ROLL



Lift the paper to expose the front of the recorder. With the other hand push the pressure roll bar INWARD then UPWARD, releasing the pressure roll.

9. THREAD PAPER BEHIND PRESSURE ROLL



Thread paper downward, behind the pressure rollers.
Pull until a few inches of paper extend downward.
Press interlock while positioning paper over interlock and under the guide.
The recorder runs only if the interlock switch is held in by the recording paper.
Lower the pressure roll assembly until it locks.
Recorder is ready for use.

10. THREAD PAPER

Thread paper through slot at bottom edge of paper table.

11. INSTALL TAKE UP SPINDLE

Slide paper core HP No. 07858-28390 over takeup spindle.
Place left end of spindle into bracket.
Pull out knob to allow spindle to drop into position.
Lower the right spindle end into position.
Rotate the spindle until it locks into place.

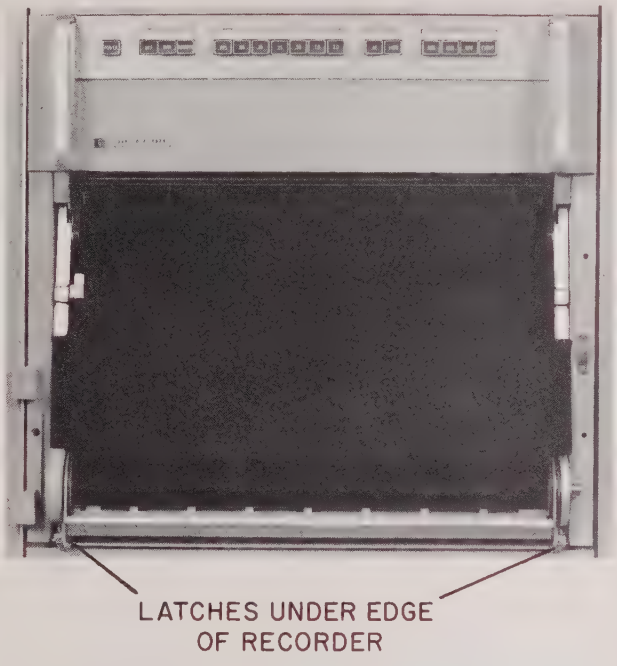
12. LOCK PAPER ONTO TAKE UP SPINDLE

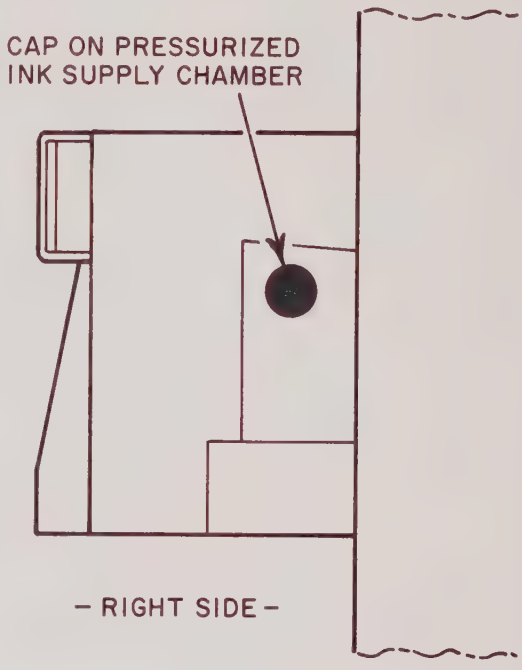
Thread paper onto takeup spindle as shown in threading diagram.
Rotate the spindle seven times in the direction shown while holding the paper TIGHTLY on the spindle.

13. CLOSE AND LOCK PAPER TABLE

Slowly raise paper table.
With table in near vertical position, thread paper into interlock (see step 9).
Raise levers fully upward, and push table inward until it hits stops.
Pull paper taut over platen and push one lever downward to locking position. Lock other lever.
Recorder is ready for use.

Figure 3-5 Roll Paper Loading Procedure





1	Ink supply may be renewed without interrupting recording.
2	Move latches toward outside of cabinet.
3	Pull Recorder out far enough to lock slides.

A. SLIDING OUT RECORDER

1	Remove cap on ink chamber; push in, turn slightly counterclockwise, pull off.
2	Remove plastic ink bottle.
3	Put new bottle in place, cap inward.
4	Replace cover firmly. This engages new bottle with fluid system.
5	Slide recorder back into cabinet.

B. CHANGING BOTTLE

Figure 3-6. Replacing Ink Supply

NOTES

SECTION IV
PRINCIPLES OF OPERATION

4-1. SCOPE.

4-2. This section explains the operating principles of the Fluid Recorder. The pen motors and their electronic drive, the ink supply and ink control, the chart drive and control, and the Power Supply for these items are discussed. Preamplifiers and ancillary equipment are not generally explained in detail, since principles of these items are discussed in the respective Operating and Service Manuals. However, the Power Supply used with modular 8800 Series Preamplifiers is explained.

4-3. A discussion of basic semi-conductor circuits is followed by an introductory explanation of the System Functional Block Diagram, Figure 4-1. Other block diagrams and partial schematics are used in this section, while complete schematics and drawings will be found in Section VI.

4-4. BASIC SEMICONDUCTOR CIRCUITS.

4-5. The Diode.

4-6. Diodes are used in the recording system principally as rectifiers and regulators. Rectifier diodes are used to change ac power to dc power through the use of their characteristic of high conduction in one direction or polarity and almost none in the other. Figure 4-2A shows a typical full wave circuit in which two diodes are used to charge a filter capacitor on alternate halves of the ac cycle.

4-7. REGULATOR. A diode regulator uses either the constant reverse-bias breakdown voltage characteristic of a breakdown diode or the constant forward-bias voltage drop characteristic of a silicon diode. Power supply reference voltages are generally provided by breakdown diodes which maintain a constant voltage when supplied with a reverse-bias voltage greater than their specified breakdown voltage. Regulated voltages can also be provided by a forward-biased silicon diode which maintains a constant 0.6 to 0.8 volt drop. Figure 4-2B shows connections for both types of diodes.

4-8. The Transistor.

4-9. Transistors are used throughout the system as amplifiers having voltage, current, or power gain. In the following paragraphs, basic transistor operation and a few basic transistor circuits are discussed. These paragraphs discuss the easily observed changes

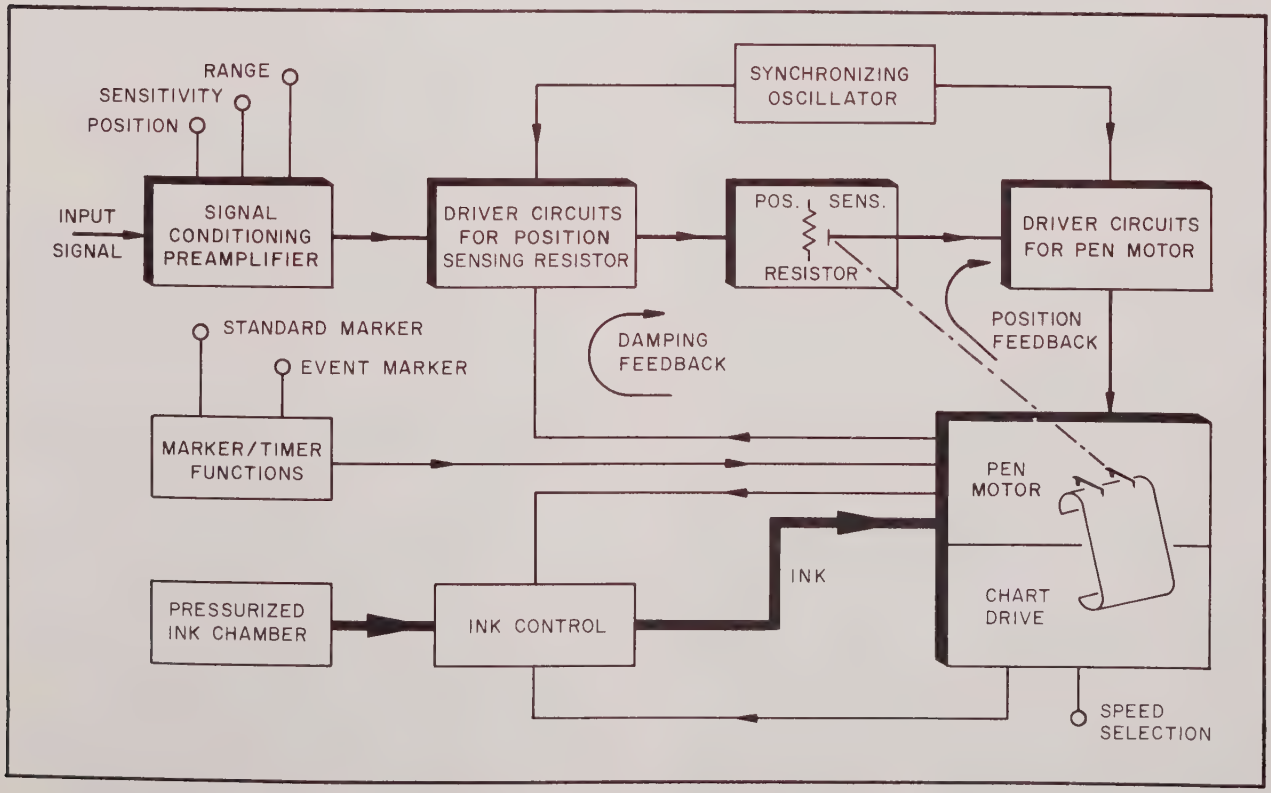
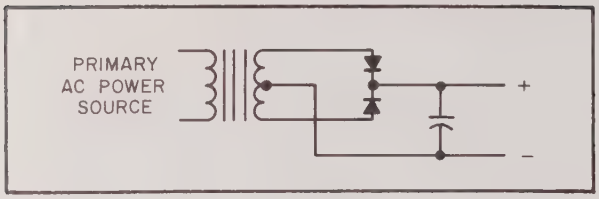


Figure 4-1. Functional Block Diagram, Fluid Recorder System

A. Full Wave Rectifier Circuit



B. Regulator

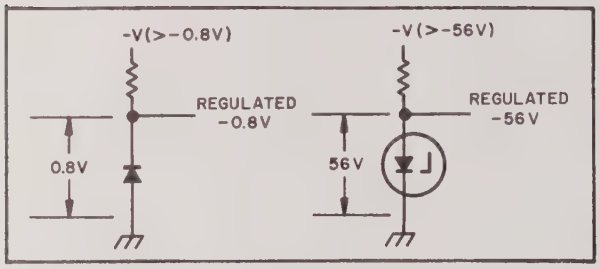


Figure 4-2. Basic Diode Circuits

in currents and voltages in transistor circuits which help technicians locate circuit faults but do not attempt to describe how transistors work internally.

4-10. BIASING AND CONDUCTION. In a transistor a small base-to-emitter current controls a large collector-to-emitter current. A comparison of NPN transistor and PNP transistor operation is shown in Figure 4-3B, indicated current represents conventional flow of positive charges external to the transistor and is not intended to indicate flow of carriers inside the transistor structure. Notice that the effect of emitter-base-collector voltages is totally reversed between NPN and PNP transistors; circuits which are arranged for an NPN transistor usually function normally for a PNP transistor if supply voltages are reversed.

4-11. AMPLIFIERS. Three basic amplifier types are available (Figure 4-3A). These amplifiers may be used alone or in combination to form complex circuits.

4-12. FIELD EFFECT TRANSISTOR (FET). Field effect transistors have three terminals: source, drain, and gate which correspond in function to emitter, collector, and base of junction transistors. Source and drain leads are attached to the same block (channel) of N or P semiconductor material. A band of oppositely doped material around the channel (between the source and drain leads) is connected to the gate lead.

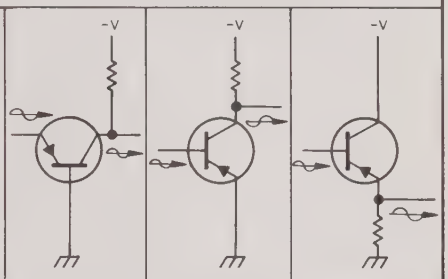
4-13. In normal FET operation, the gate-source voltage reverse-biases the PN junction, causing an electric field that creates a depletion region in the source-drain channel. In the depletion region the number of available current carriers is reduced as the reverse-biasing voltage increases, making source-drain current a function of gate-source voltage. With the input (gate-source) circuit reverse-biased, the FET presents a high impedance to its signal sources (as compared with the low impedance of the forward-biased junction transistor base-emitter circuit). Because there is no input current, FET's have less noise than junction transistors. Figure 4-4 shows the schematic symbol and biasing for N channel and P channel field effect transistors.

4-14. FUNCTIONAL CONCEPTS.

4-15. Signal Measurement.

4-16. Refer to Figure 4-1. Preamplifiers are selected in accordance with the phenomena to be measured. In each channel, such a unit amplifies or otherwise conditions the incoming signal to produce a standardized output. The remaining electronic

A. Amplifier Characteristics



CHARACTERISTIC	COMMON BASE	COMMON EMITTER	COMMON COLLECTOR
Input Impedance	30Ω – 50Ω	500Ω – 1500Ω	20KΩ – 500KΩ
Output Impedance	300KΩ – 500KΩ	30KΩ – 50KΩ	50Ω – 100Ω
Voltage Gain	500 – 1500	300 – 1000	>1
Current Gain	>1	25 – 50	25 – 50
Power Gain	20dB – 30dB	25dB – 40dB	10dB – 20dB (Emitter Follower)

B. Transistor Biasing

TYPE	CUTOFF	CONDUCTION
NPN	+V, 0V	+V, MAIN CURRENT, +V, CONTROL CURRENT
PNP	-V, 0V	-V, -V, CONTROL CURRENT, MAIN CURRENT

Figure 4-3A. Transistor Operation

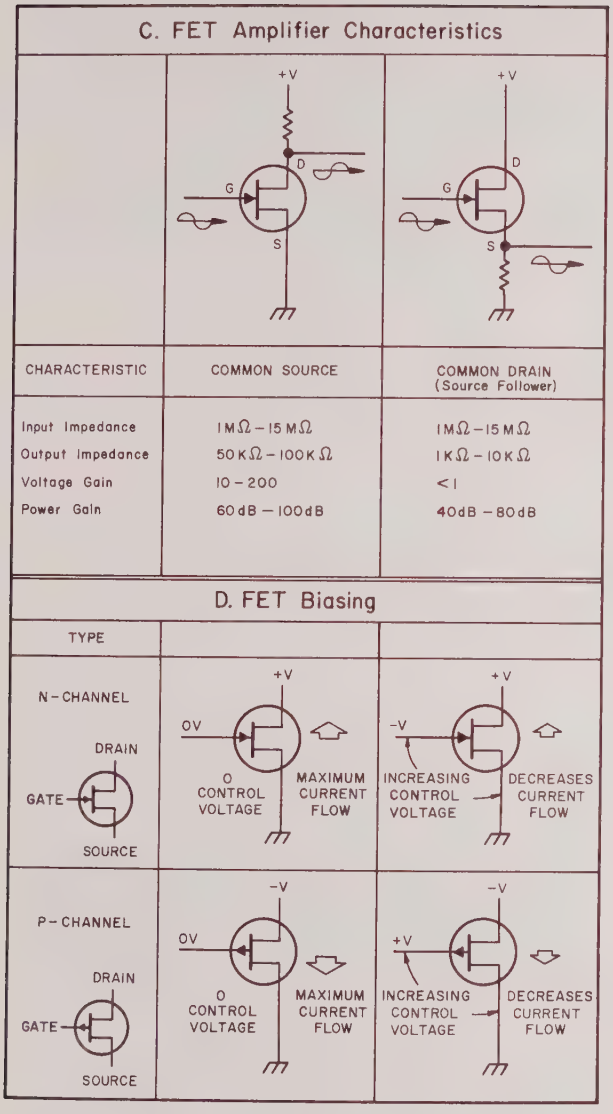


Figure 4-3B. Field Effect Transistor Operation

treatments of the signal and its by-products occur in the Driver modules or in the Pen Motor Preamplifier (part of Pen Motor Drive Circuits in Figure 4-1).

4-17. After conditioning, the incoming signal is applied to a wide-band operational amplifier. The operational amplifier output drives a voltage divider system positively or negatively in accordance with the instantaneous value of the conditioned signal. Action is such that the zero voltage point of the divider, relative to ground, is moved from the center of the divider (under no signal conditions) to the normally positive or negative areas of the divider. This constitutes a physical movement of a null point on this divider (and on the position sensing resistor) in accordance with the voltage or current values of the original signal.

4-18. A chopping action is accomplished by two switching transistors which simultaneously ground both ends of the position sensing resistor during the same half cycle of the synchronizing oscillator. This modulates the voltage information on the position sensing resistor and produces on it a phase and amplitude distribution of high frequency square waves.

4-19. A capacitive pick-up attached to the pen arm receives a signal the nature of which depends upon the input signal representation on the position sensing resistor and upon the relative position of the pen arm. If the pick-up rests above the null point, no signal is received; if it rests above a negative portion of the sensing resistor, a square wave is received having an amplitude proportional to the instantaneous voltage at that point. If the pick-up rests above a positive portion of the sensing resistor, a similar square wave is generated, but 180° out of phase in regard to the synchronous oscillator output.

4-20. After amplification and filtering, the signal derived from the capacitive pick-up is demodulated in a phase sensitive circuit employing as a reference the same oscillator output used in chopping. In-phase signals at this point produce a positive increment and out-of-phase signals a negative increment. The polarity of this error signal represents the direction in which the pen must move to reach the null point. This signal is amplified and applied to the pen motor with the polarity necessary to drive the pick-up toward the null. When nearing the null point, the error signal is reduced, thus reducing motor torque. At the null, there is no motor current. Because there is no restoring spring, the pen is stationary. Subsequent changes in the incoming signal move the null point on the position sensing resistor. The resulting mismatch between the null point and the capacitive pick-up causes a new error signal which is continuously processed to cause a motor torque to restore the pen to the null position.

4-21. Marker Timer Functions.

4-22. Left and right hand marker pens are operated by trigger circuits to cause positive displacement. Triggering is normally controlled by the EVENT button or by clock driven switches. For remote operation, triggering can also be performed by a low power, 1.5 volt pulse applied through the internal marker amplifier.

4-23. Chart Drive.

4-24. The chart paper is advanced by the drive roll at the bottom of the paper table. This roll is driven through a timing chain by the speed control assembly. Coupling between the timing chain and the speed control assembly is through reducer gears (3:1 for 60 Hz operation, 2.5:1 for 50 Hz operation) which also provide the correct direction of rotation for the drive roll.

4-25. The speed control assembly consists primarily of five modular gear boxes with 2:1, 4:1, and 10:1 fixed ratios. Solenoid selection results in straight through drive (1:1) for any speed reduction module.

4-26. Input to the speed reduction modules is from a synchronous motor operating at 1800 rpm (when powered from a 60 Hz line) through a 5:1 timing belt and pulley reduction.

4-27. Ink Control.

4-28. Ink is contained in a flexible sack inside a plastic bottle. Air pressure generated in the Recorder is applied to the outside of the sack thus pressurizing the ink. Through the medium of a selection of regulated air pressures, the pressure of the ink applied to the pens is varied in accordance with the chart drive speeds.

4-29. The pressure of the ink supplied to each pen is modulated through a pinch pump in accordance with the signal driving the related pen motor. This results in a greater flow of ink when the pen moves fast, thereby maintaining line continuity and width.

4-30. Excessive excursions of ink pressure caused by the demands of the writing speed and the action of the pinch pump are absorbed by a small plastic-tube accumulator near the pen tip.

4-31. Ink supply to all pens is cut off by pinch valves when the chart drive is stopped.

4-32. PREAMPLIFIER THEORY OF OPERATION.

4-33. Preamplifier theory of operation is given in the Preamplifier Instruction Manual.

4-34. DRIVER AMPLIFIER-PEN MOTOR PRINCIPLES

4-35. In addition to the partial schematics included with this discussion, complete schematic diagrams for Driver Amplifier Printed Circuit Board, Model 7850-62010 are included at the rear of the manual.

4-36. Input and Limiters.

4-37. The input to the Driver Amplifier Board under normal signal conditions, and after adjustment for on-scale pen deviations, seldom exceeds full scale conditions. Pens must be protected from unusual excursions, however. In addition, excessive input voltages could cause hysteresis errors due to circuit saturation and resulting recovery times. The separate upscale and downscale limiting circuits are shown in Figure 4-4. They are designed to preserve linearity of response to all signals below the set limit.

4-38. The input signal from the Preamplifier Module is voltage amplified by transistor Q21 which is direct-coupled to Q20. The Q20 grounded emitter stage has 100% inverse voltage feedback to the emitter of Q21, resulting in unity gain for the pair. In addition, signals with amplitudes greater in the positive direction than a selected value cause voltage drops across the R60, R61 series resistances sufficient to raise the Q21 emitter nearly as positive as its collector. Further positive advances can have no additional effect on the output. The point at which saturation occurs is established by the setting of R60.

4-39. Diode CR5 protects transistor Q21 against reverse emitter-base voltages and also provides an additional drop (about 0.5volts) helpful in completely cutting off Q21.

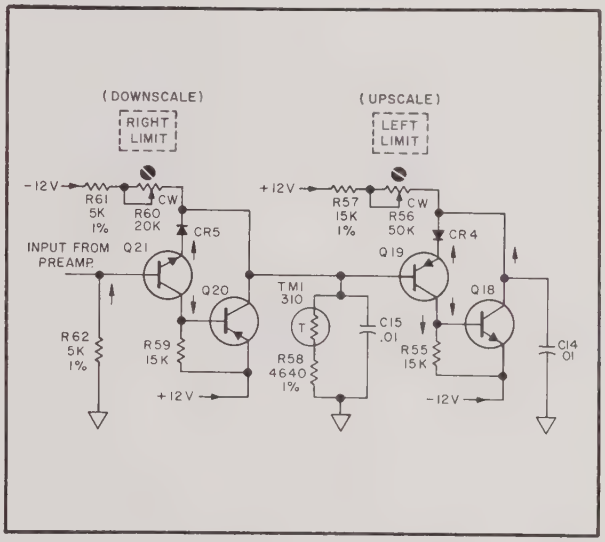


Figure 4-4. Limiter Circuits

4-40. A similar circuit using a PNP transistor in place of the NPN and vice versa, is used for upscale limiting. Proper voltage for direct coupling between the two stages of limiting is maintained by R58 and TM1 in series. TM1 is a temperature compensating resistor. Capacitor C15 corrects for phase shift.

4-41. Drive for Position Sensing Resistor.

4-42. Output from the limiters is dc coupled through resistor R1 to a stabilized and frequency compensated operational amplifier employing the differential transistor pair Q1 and Q2. See Figure 4-5. This is followed by a voltage amplifier Q3 and emitter follower Q4, which drives the voltage divider R12, R13 in parallel with the position sensing resistor.

4-43. Negative feedback is applied from the output of this operational amplifier section through R9, C12, and C16 to the base of Q1. Also applied to the base of Q1 is the damping signal feedback from the pen motor velocity coil, which feedback is adjustable by means of R49. Overall damping is adjusted for 71% to provide optimum frequency response.

4-44. Error Signal Modulation.

4-45. The voltage developed across R12 and R13 and also across the position sensing resistor is representative of the signal to be measured, in the manner described (under Functional Concepts, Signal

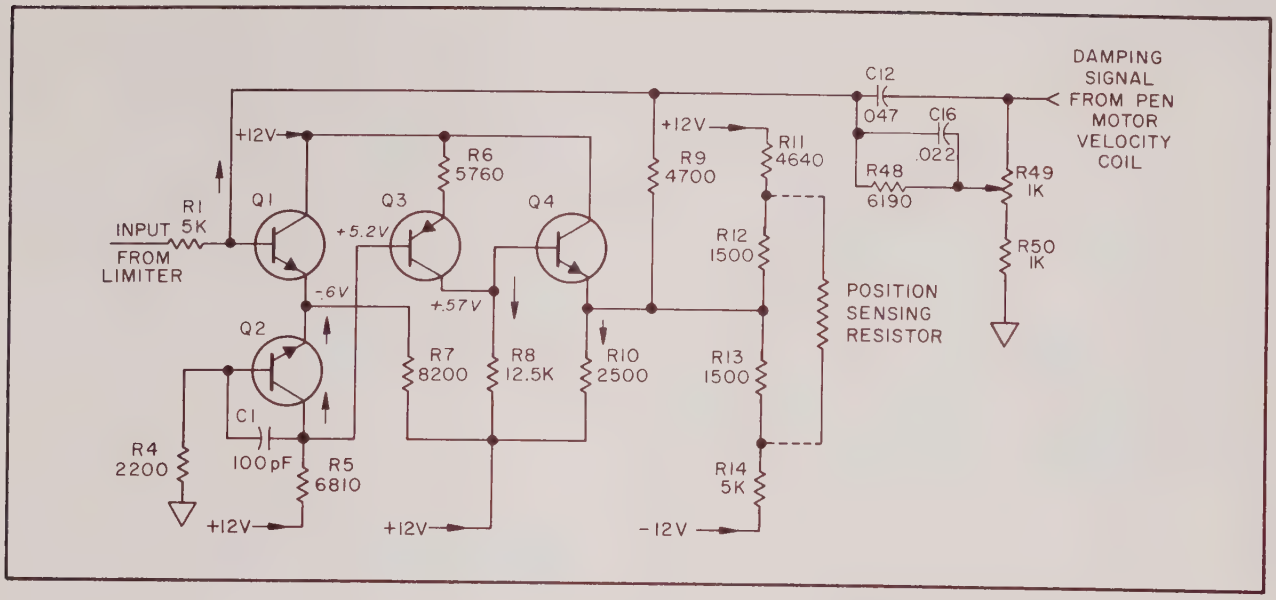


Figure 4-5. Operational Amplifier for Position Sensing Resistor

Measurements, in Paragraph 4-15). For stability and to permit capacitive pick-up from the position sensing element, the signal is modulated at this point by a 20kHz oscillator output as shown in Figure 4-6. Opposite phases of the 20kHz voltage are applied to the bases of NPN transistor Q5 and the PNP transistor Q6. These transistors have switching characteristics with very short transfer times between the fully conducting and the fully cut off states. When the top output line of the oscillator is positive, the lower line is negative. During this half cycle transistors Q5 and Q6 are forced into conduction simultaneously. With both ends of the position sensing resistor effectively at ground potential, the pick-up at the pen electrode falls to zero regardless of its position along the sensing Resistor.

4-46. On the other half cycle, Q5 and Q6 are nonconducting and the voltage seen by the pen electrode switches abruptly to the positive or negative value of the error signal. Since later manipulation of this square wave signal depends upon synchronism with the same oscillator, it can be considered that the first half of each cycle is that which cuts off transistors Q5 and Q6 and the second half is that which makes both transistors fully conducting. Referring to Figure 4-7, it will be seen that square waves resulting from positive error signals are 180° out of phase with those resulting from negative error signals. Since the circuits which follow do not maintain the dc reference, only the phase difference emerges. Figure 4-8 shows signals found at representative points along the position sensing resistor when the null is at the center; i.e., when

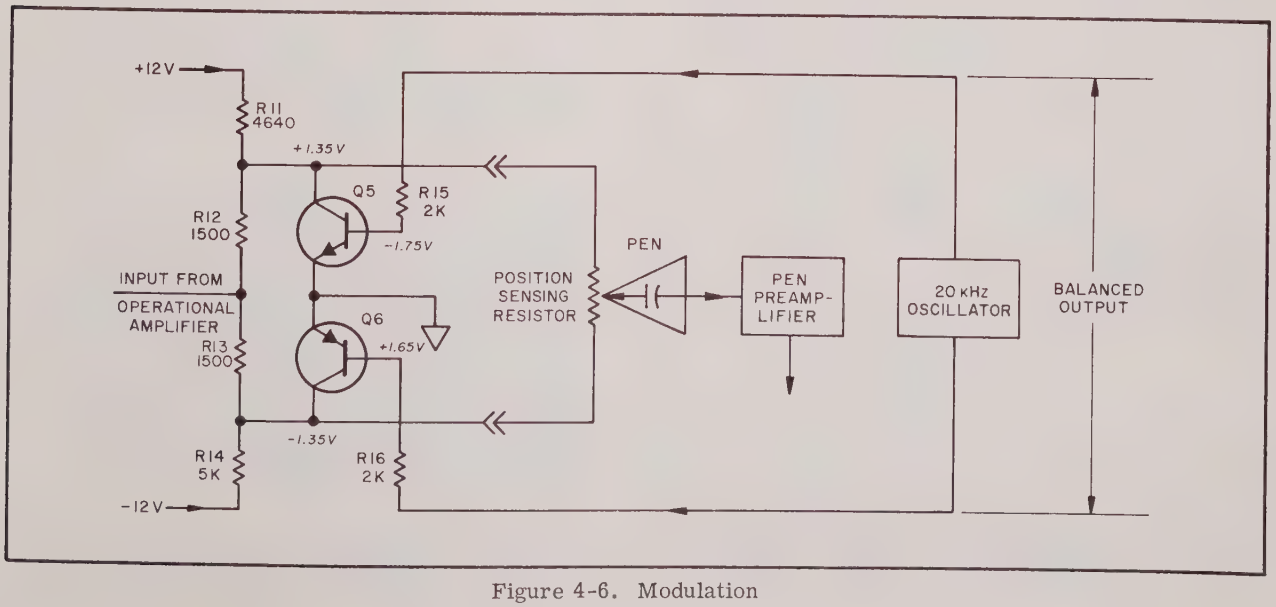


Figure 4-6. Modulation

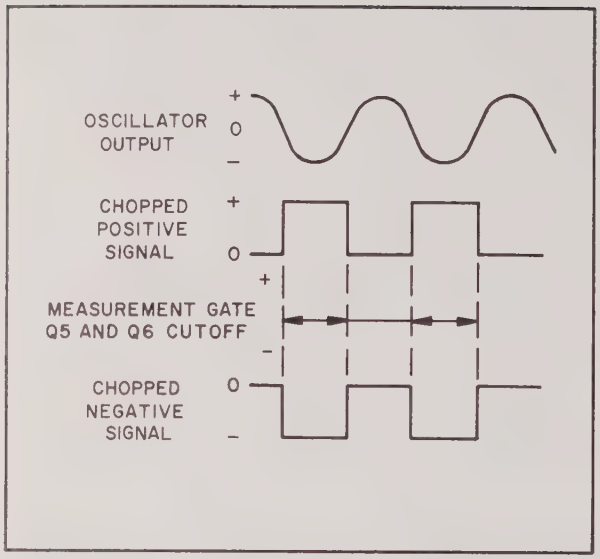


Figure 4-7. Phase Relations of Chopped Signals

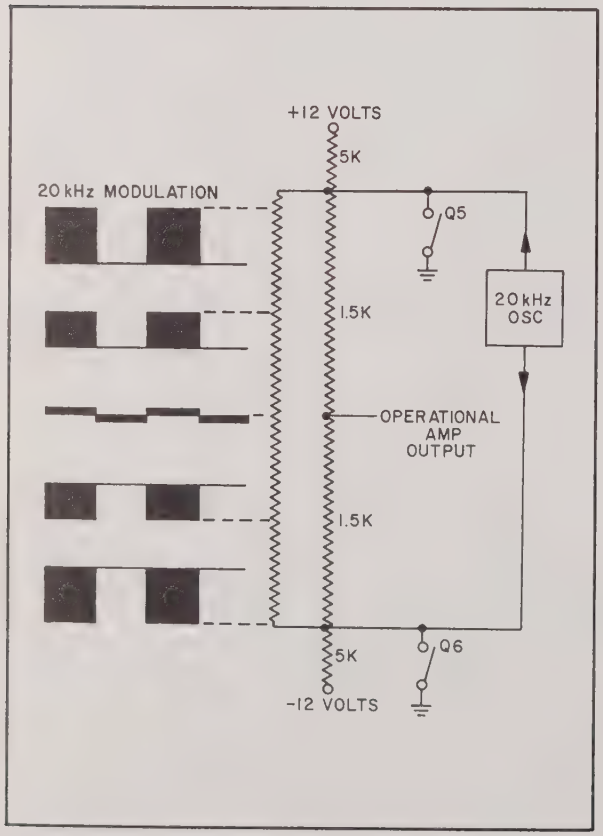


Figure 4-8. Signals Along Position Resistor, Null at Center

input from the signal conditioning preamplifier is zero. Figure 4-9 shows the distribution of square wave peak voltages across the position sensing resistor for three locations of the null.

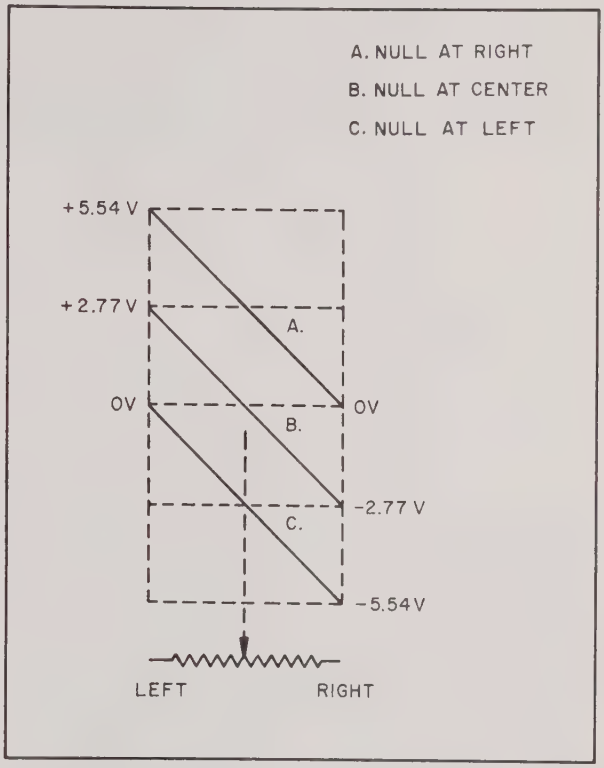


Figure 4-9. Voltages Across Position Sensing Resistor with Null at Three Points

4-47. Pen Preamplifier.

4-48. The Preamplifier printed circuit board is mounted on the pen motor assembly to avoid extraneous pick-up at the low signal level of the input circuit. The extremely high input impedance in this preamplifier, obtained through the use of a field effect transistor (FET), permits efficient pick-up of the 20 kHz signal through the minute capacitance between the pen electrode and the position sensing resistor. Of equal importance is that the ratio of pick-up impedance to amplifier input impedance be small in order that small changes in electrode-resistor spacing will not create large changes in effective signal input. The total gain of the Preamplifier is about 8.

4-49. Error Signal Amplifier and Filter.

4-50. A shielded lead conducts the error signal from the pen Preamplifier to the Driver Amplifier printed circuit board. The signal is first conditioned by a buffer amplifier consisting of Q7 and Q8 in a stabilized circuit, as shown in Figure 4-11. The output from Q8 is coupled to the base of Q9 through the resonant circuit determined by inductor L1 and capacitor C5. Diode CR1 limits the negative-going signal applied to L1. An adjustment in the inductance of L1 permits a correction for a small phase angle error which may otherwise develop. Q9, operating as an emitter follower (common collector circuit) serves to prevent the following stage from loading the resonant circuit.

4-51. Demodulator.

4-52. The signal applied to the demodulator is a square wave at 20kHz, with a phase (relative to the reference signal) indicating the direction in which the pen must move in order to reach the null on the position sensing resistor and an amplitude representative of, but not necessarily proportional to, the distance between the pen and the null. This must be translated into a positive or negative voltage to be applied to the pen motor.

4-53. The signal is applied to the balanced inputs of transistors Q10 and Q11 in Figure 4-12. Also applied to the inputs is the reference 20kHz, but in opposite phase (C, D) to Q10 and Q11 bases. Detection occurs at the emitters as signals of one phase cause a positive accumulation across C6 at the Q10 emitter, while signals of the other phase cause a negative accumulation across C7 at the Q11 emitter. Summing occurs at C8 with a positive or negative indication available at a substantial signal level.

4-54. Pen Motor Drive Amplifier.

4-55. As shown in Figure 4-13, coupling between all stages from the detector to the pen motor are direct connections. The input stage for this amplifier is a differentially connected transistor pair, Q12 and Q13,

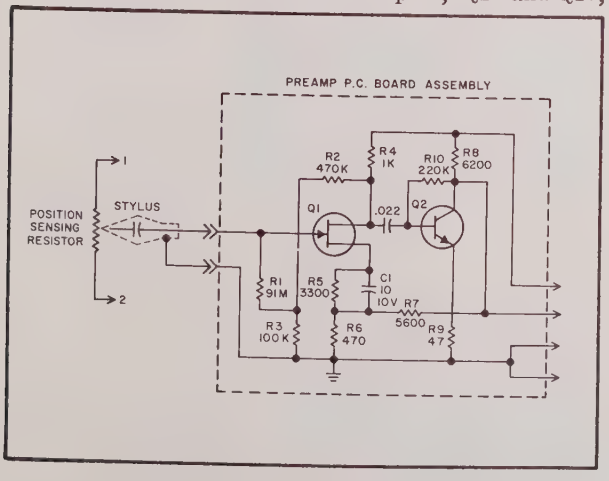


Figure 4-10. Pen Preamplifier

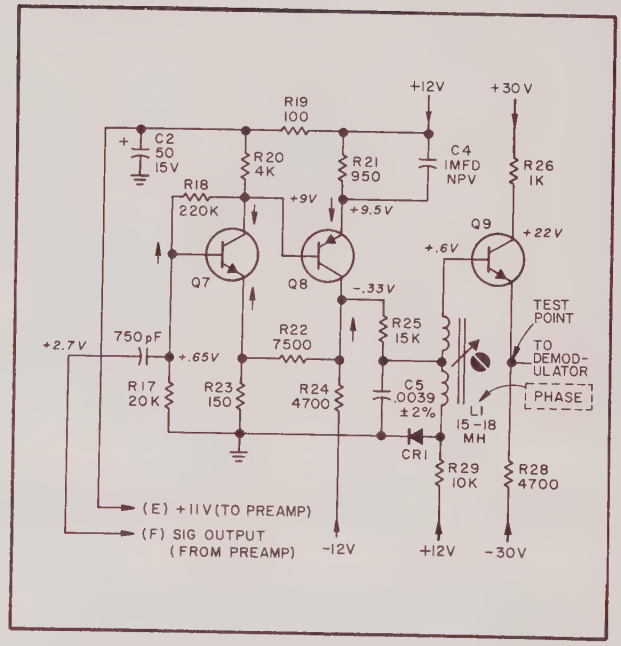


Figure 4-11. Buffer Amplifier and Filter

with corrective feedback to the base of Q13 from the pen motor coil. Q14 takes an amplified signal from the collector of Q13 and its collector delivers a voltage amplified signal to the base of Q15. To drive the output transistors, Q15 is chosen to control appreciable power in the signals of either polarity. The emitter voltage of Q15 is stabilized through the use of the breakdown diode CR3.

4-56. Output to the pen motor coil is obtained from the complementary transistor pair Q16, Q17 which can drive either positively or negatively. The voltage applied is limited in either direction by breakdown diodes CR2 and CR6. Note that this does not limit pen travel, as do the input limiters (Paragraph 4-36)

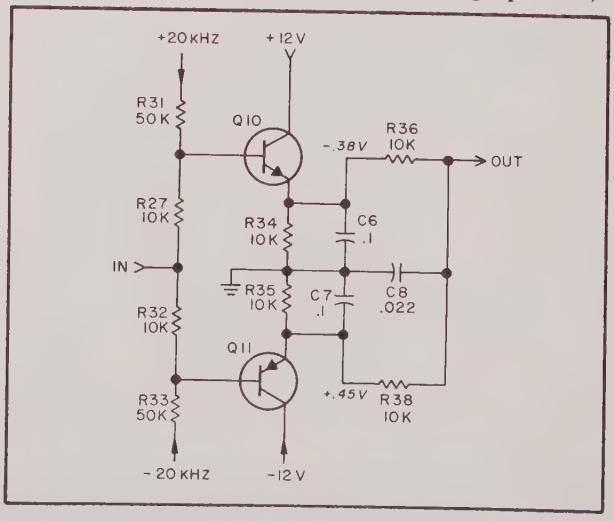


Figure 4-12. Demodulator Circuit

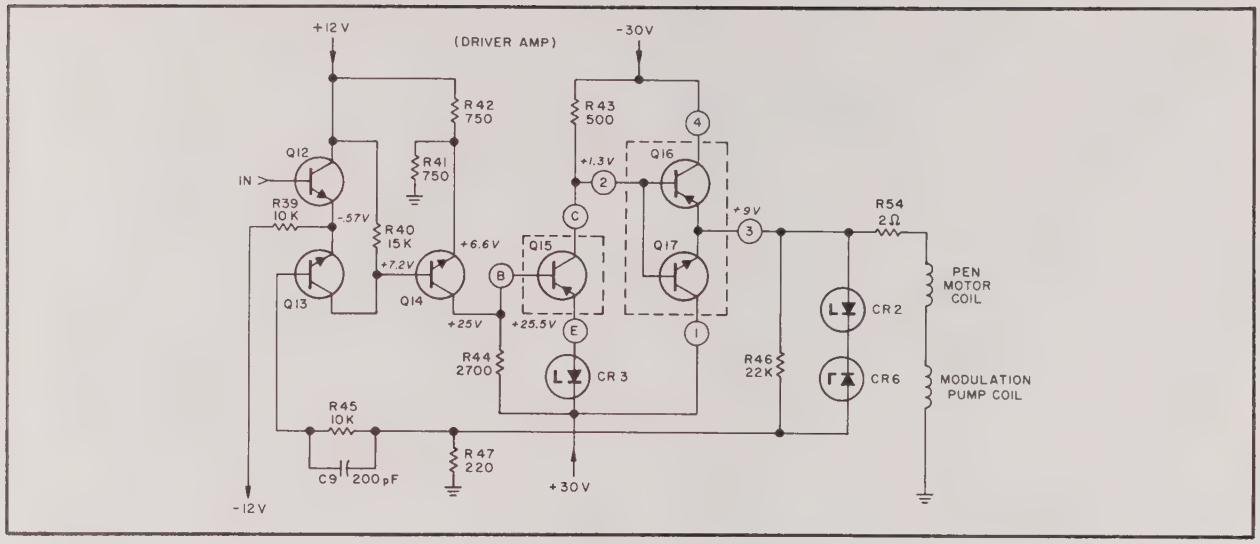


Figure 4-13. Pen Motor Drive Amplifier

but only the maximum voltage applied to the motor. Note also that the return for the pen motor coil is through the ink modulation pump coil. This results in a momentary increase in writing fluid pressure whenever the pen is accelerated in either direction.

4-57. Pen Motor and Linkage.

4-58. The pen motor is shown in simplified drawings in Figure 4-14. The conventional D'Arsonval galvanometer movement has a large external magnet and a soft iron core. The 7848A Recorder pen motor uses a magnetized core and a soft iron shell. For a given torque, this results in a smaller, lighter unit. In addition, stray fields are greatly reduced by the

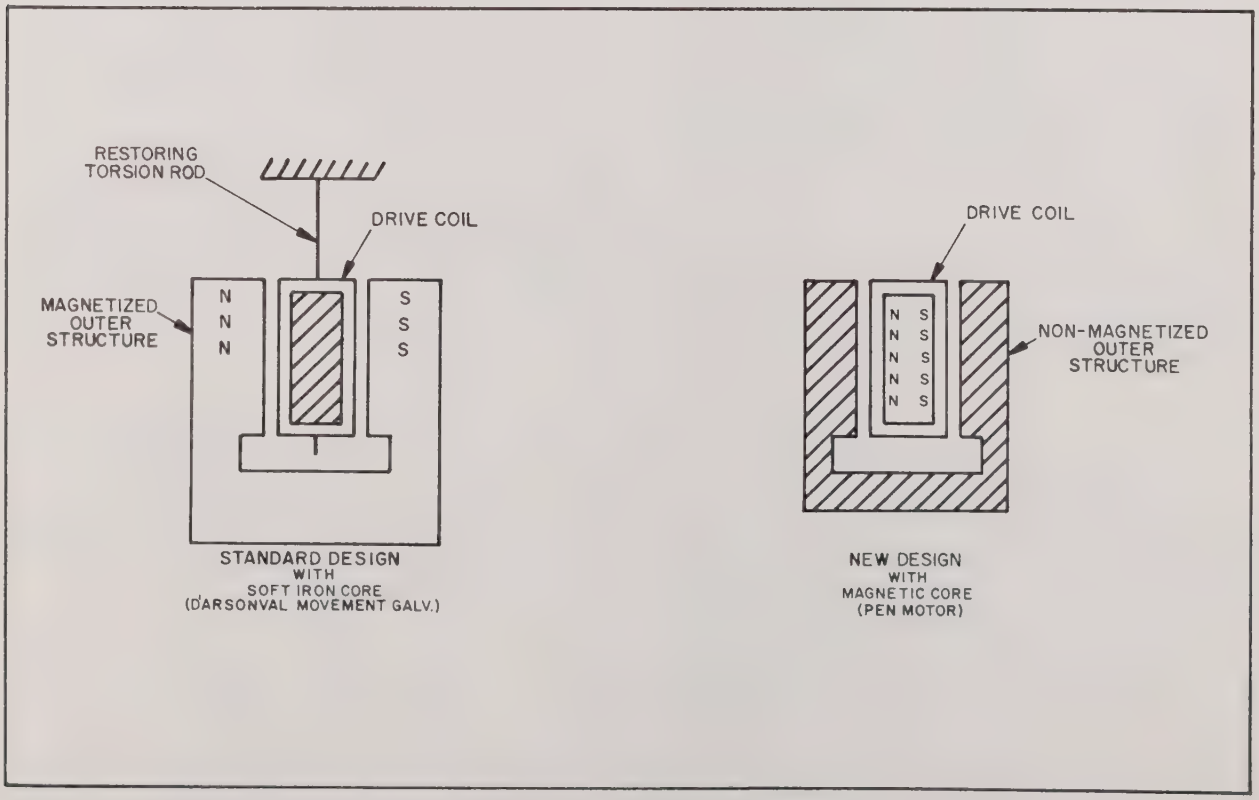


Figure 4-14. Pen Motor Design

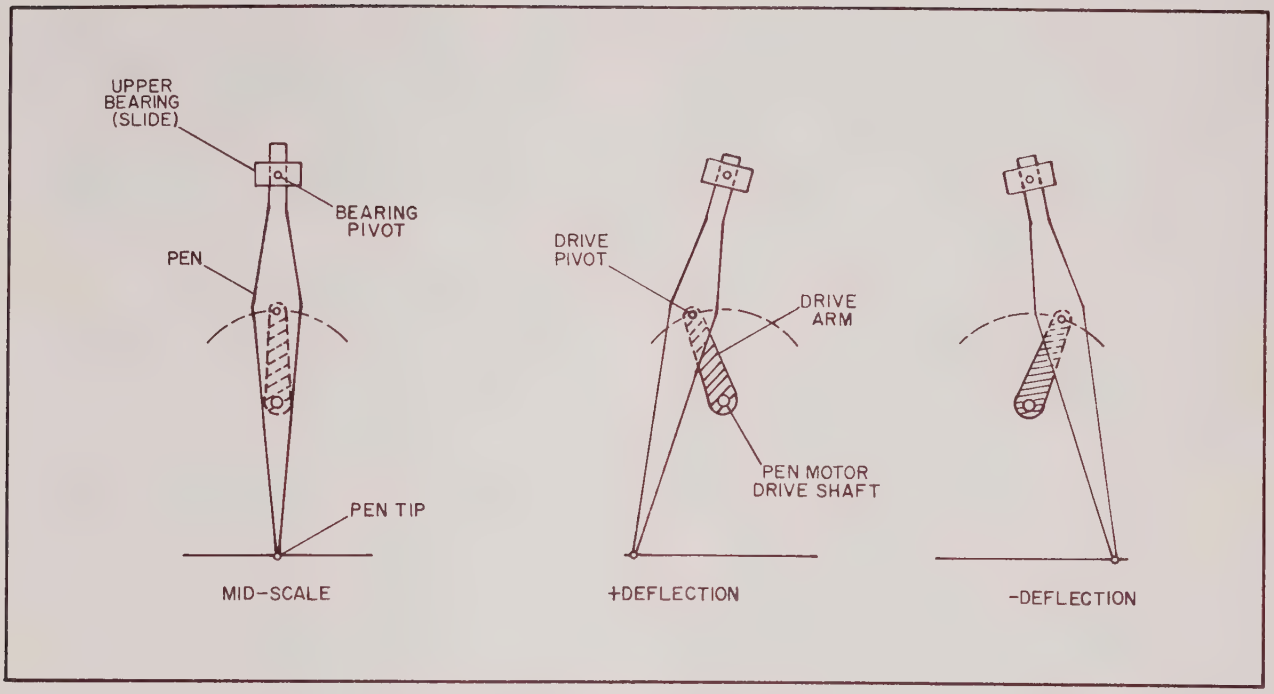


Figure 4-15. Pen Drive Linkage

shielding effect of the soft iron outer structure so that no special adjustments or extra shielding are needed in multi-channel use in which pen motors are mounted side-by-side.

4-59. The use of the feedback positioning circuit eliminates the need for a torsion rod or centering spring. This enhances the frequency response. Instead of being dependent upon a restoring force, motion in either direction is accomplished by the electrical drive.

4-60. To obtain a rectilinear writing system from the rotary motion of the pen motor, the linkage system shown in the simplified drawing in Figure 4-15 is used. The pen motor turns its drive arm and moves the drive pivot at the end of this arm through a circular arc. The drive pivot moves the corresponding point on the pen assembly through the same arc, but because the upper end of the pen assembly is constrained by the upper bearing and pivot, the pen tip moves along a straight line. The upper end of the pen assembly is free to move back and forth through the slide bearing which also pivots to follow the motion of the pen.

4-61. Compensation and Damping.

4-62. Although it is not a conventional galvanometer, the response of the pen motor, when combined with its driving circuits, is basically similar to a conventional galvanometer. Figure 4-16 shows a typical representation of the effects of damping. An underdamped pen motor has a peaked frequency response and an oscillatory transient response. An overdamped pen motor has a frequency response which drops off gradually at high frequencies, and a slow transient response. An optimum occurs at approximately 71% damping, where the frequency response is down 3 dB at the natural frequency, and where the response to a step input shows approximately 4% overshoot.

4-63. A block diagram of the Driver Amplifier and pen motor is shown in Figure 4-17, including the damping and compensation adjustments. One channel only is shown; all channels of the system have the same configuration.

4-64. Note that damping is a force which (1) is proportional to velocity, and (2) is in a direction opposed to the original velocity. A voltage is induced in the velocity-voltage winding of the pen motor, proportional to the coil velocity through the magnetic field. A feedback (damping) voltage returned to the Driver Amplifier consists of two components: (1) a component proportional to drive current, originating in the modulation pump coil, and (2) the velocity voltage component. These components are returned to the

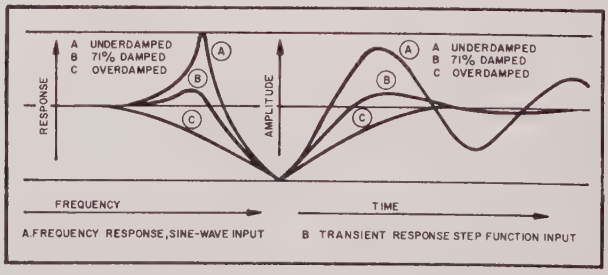


Figure 4-16. Pen Motor Frequency and Transient Response, at Different Values of Damping

amplifier circuits in such a phasing as to oppose the motion of the pen motor. The function of component (1) is to keep the current through the drive portion of the galvanometer coil proportional only to the amplifier input voltages (current feedback), and independent of coil resistance, which may change with change in coil operating temperature. The function of component (2) is to provide the damping for the motion of the pen motor. The function of the DAMPING control is to adjust the amount of damping to an optimum value. The function of the COMPENSATION control is to introduce a high-frequency pre-emphasis opposite to the high-frequency roll-off of the uncompensated system. to extend the frequency response. The result is a system for which the transient and frequency response are at their optimum values, as obtained from the adjustment to 71% of critical damping.

4-65. DRIVER AMPLIFIER POWER SUPPLY PRINCIPLES.

4-66. The Driver Amplifier power supply is mounted on a detachable chassis at the rear of the Recorder. The functions incorporated on this chassis include the filtering and control of primary ac power, step-down, rectification, and filtering for several dc voltages, regulation for positive and negative 12 Vdc lines, generation of a 20kHz reference signal chart motor control, timer signal generation, and amplification for two marker pens. A block diagram is given in Figure 4-18.

4-67. Unregulated DC Power.

4-68. As seen in Figure 4-2, both sides of the ac primary power line are filtered before application to the main transformer, T1. From separate full wave rectifiers on the tapped secondary of T1 (diodes CR1, etc.) dc voltages of +27, +30, and -30 are produced. The +27 Vdc is not filtered, since it is used only to energize relays and solenoids. The +30 Vdc and -30 Vdc are heavily filtered by C1 and C2. L1 is a swinging choke which provides voltage regulation against load variations. (Heavier currents saturate the core causing an increase in the peak energy reaching the filter capacitors. All supplies have a common return.

4-69. Regulator for +12 Vdc.

4-70. This regulator reduces the nominal 30 volt output from the supply described above and stabilizes the 12 volts for use in circuits of the Driver Amplifiers. Refer to Figure 4-20.

4-71. The voltage from the regulator is sensed at R16, part of a divider across the regulator output. The voltage is applied to one input of the differential transistor pair Q3, Q6 and compared to the other input from a breakdown diode, CR6. The series resistor R13 limits base current in Q6 during turn-on and shut-down transients.

4-72. To provide an adequate voltage swing for the widest points of the operating range, the +12 volts is not used for the emitter return of the differential pair. A 20.6 volt line is provided through the use of breakdown diode CR5. This also provides a satisfactory voltage source for the reference diode, CR6.

4-73. The signal resulting from the comparison in the differential amplifier is direct-coupled from the collector of Q6 to the base of the intermediate voltage amplifier stage employing Q2. To establish the correct voltage for direct coupling, the emitter of Q2 is returned to the divider R2, R3 which is heavily bypassed by C3 to maintain high frequency response.

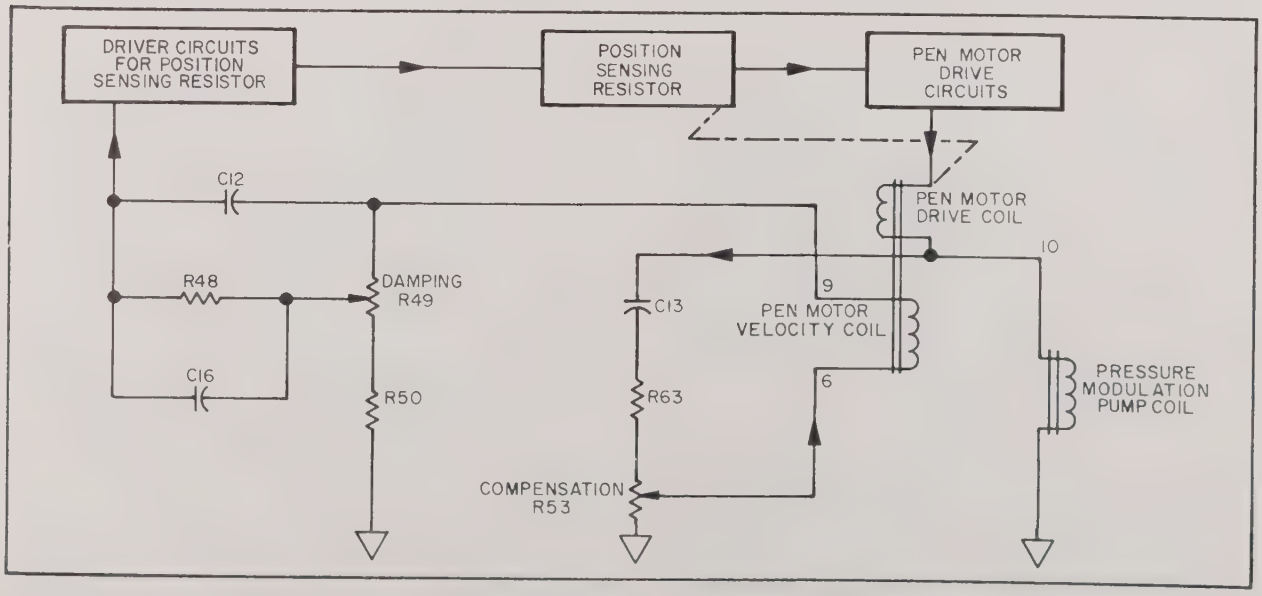


Figure 4-17. Pen Motor with Damping and Compensation Feedback

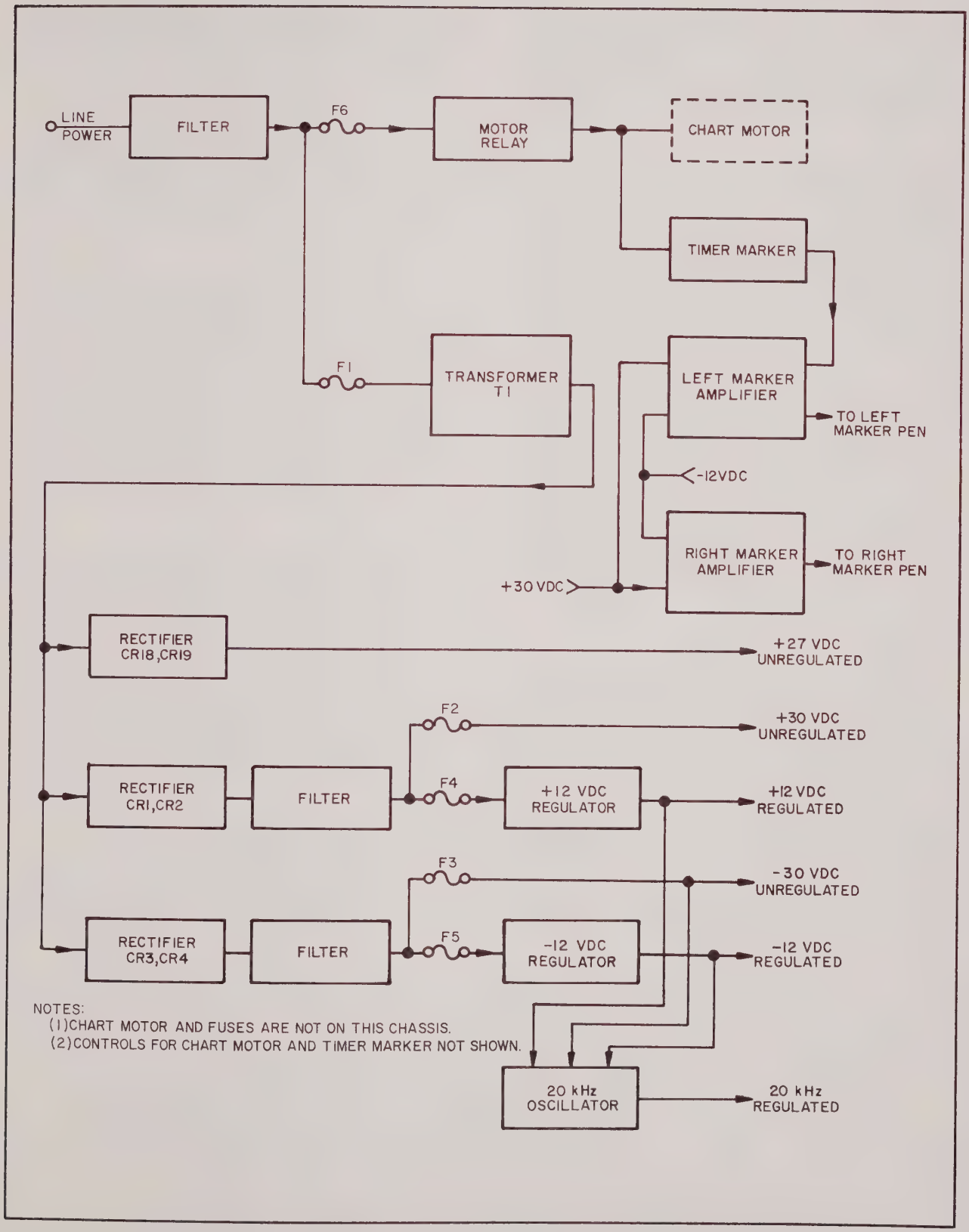


Figure 4-18. Driver Amplifier Power Supply, Block Diagram

The collector of Q2 is direct-coupled to the base of the pass transistor Q1. To provide for the condition of very low drains through the regulator, a small voltage drop across R5 is applied to the base of Q1 through R4 if Q2 is driver to collector cut-off. This in turn would allow Q2 to become more nearly cut-off.

4-74. The output impedance of the regulator at high frequencies is maintained at a low value by the output capacitor C6. Note that the lower end of C6 is connected to Pin 9 of the printed circuit board, which is the Driver Amplifier return. The dc return for the regulator to the secondary center tap of transformer T1 is made to the dc common line in the Transfer Chassis. This allows the regulator to compensate for varying voltage drops in the cables and connectors between the power supply and the Transfer Chassis.

4-75. Signal directions in this amplifier train are such that an increase in the voltage across the divider R13, R14 reduces the current successively in transistors Q6, Q2, and Q1. With Q1 current reduced, the voltage across R13, R14, is reduced to its former value except for an error factor which is the inverse of the loop gain. Negative changes are offset in a similar manner. The function of Q3 is to establish the comparison between the sampled output and reference voltage and to provide by its balancing actions, a temperature compensation for the differential amplifier circuit.

4-76. Regulator for -12 Vdc.

4-77. With some exceptions in detail, the negative 12 volt regulator is similar to the positive 12 volt regulator described above. Sampling in this supply is taken at the precise center of a voltage divider across both supplies in series. The reference point is the return or negative side of the positive regulator, so that the negative regulator operates to maintain the two-to-one ratio between the +12V and -12V outputs. Emitter return for the differential amplifier Q9, Q12 is also to the +12 volt output to provide adequate voltage range.

4-78. Q7, the transistor driving the pass transistor Q8, is a PNP rather than an NPN (Q2 above) so that coupling to it is made from the reference element Q9 of the differential pair instead of to the sampling side. This maintains correct phasing.

4-79. The back-biasing of the pass transistor Q8 must be done differently in the negative regulator. Voltage derived from the -30 volt unregulated supply is dropped by resistor R17 and regulated by breakdown diode CR8. This would be applied to the base of Q8 through resistor R19 if Q7 were to be cut-off.

4-80. 20 kHz Oscillator.

4-81. Transistors Q13 and Q14 are in a push-pull oscillator circuit with the frequency being determined by inductor L2 and capacitor C14. Feedback is used from the collector of each transistor to the base of the opposite transistor. The bases are also subject to an amplitude control by way of transistor Q15 which accepts rectified and filtered samples of the 20 kHz output. When output peaks exceed approximately 6 volts, Q15 tends to cut off, lowering the base voltage of the oscillating transistors and decreasing their output. The working point of Q15 is set by the precision divider, R37, R38 across the +12 volt regulated supply.

4-82. Under start conditions, Q15 lacks the bias normally supplied through rectifier diodes CR10 and CR11 and conducts heavily, facilitating the start of oscillations. During this period, the diode CR9 clamps the oscillator base, preventing an excursion more positive than the Driver Amplifier return.

4-83. Resistors R29 and R30 with capacitors C9 and C16 decouple the oscillator base circuit from the -30 volt supply and from Q15. R35 and capacitor C12 decouple the oscillator emitters from the regulated -12 volt supply. R36 is used to stabilize the oscillator circuit against changes caused by temperature variations.

4-84. Running Time Meter.

4-85. A mercury-plating type milliampere-hour meter M1 is used to tally the chart drive running time.

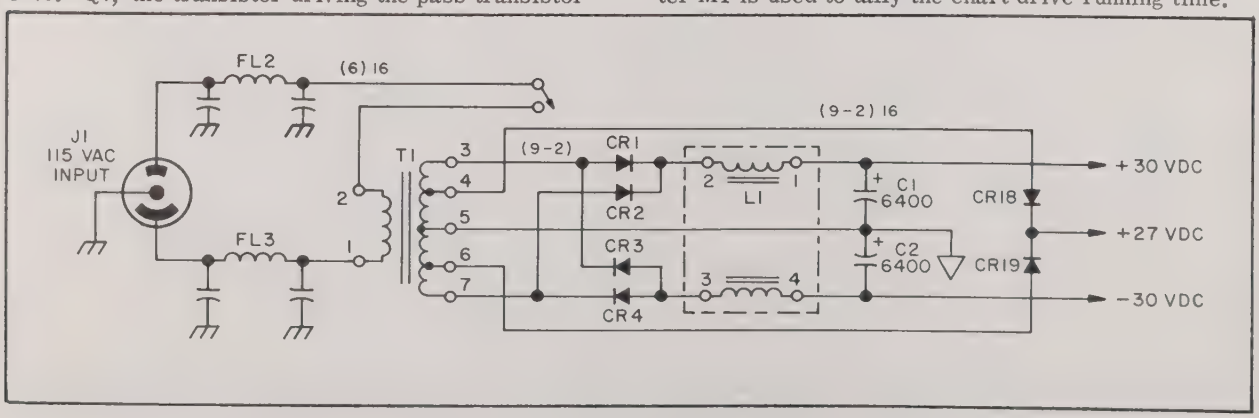


Figure 4-19. Unregulated DC Power

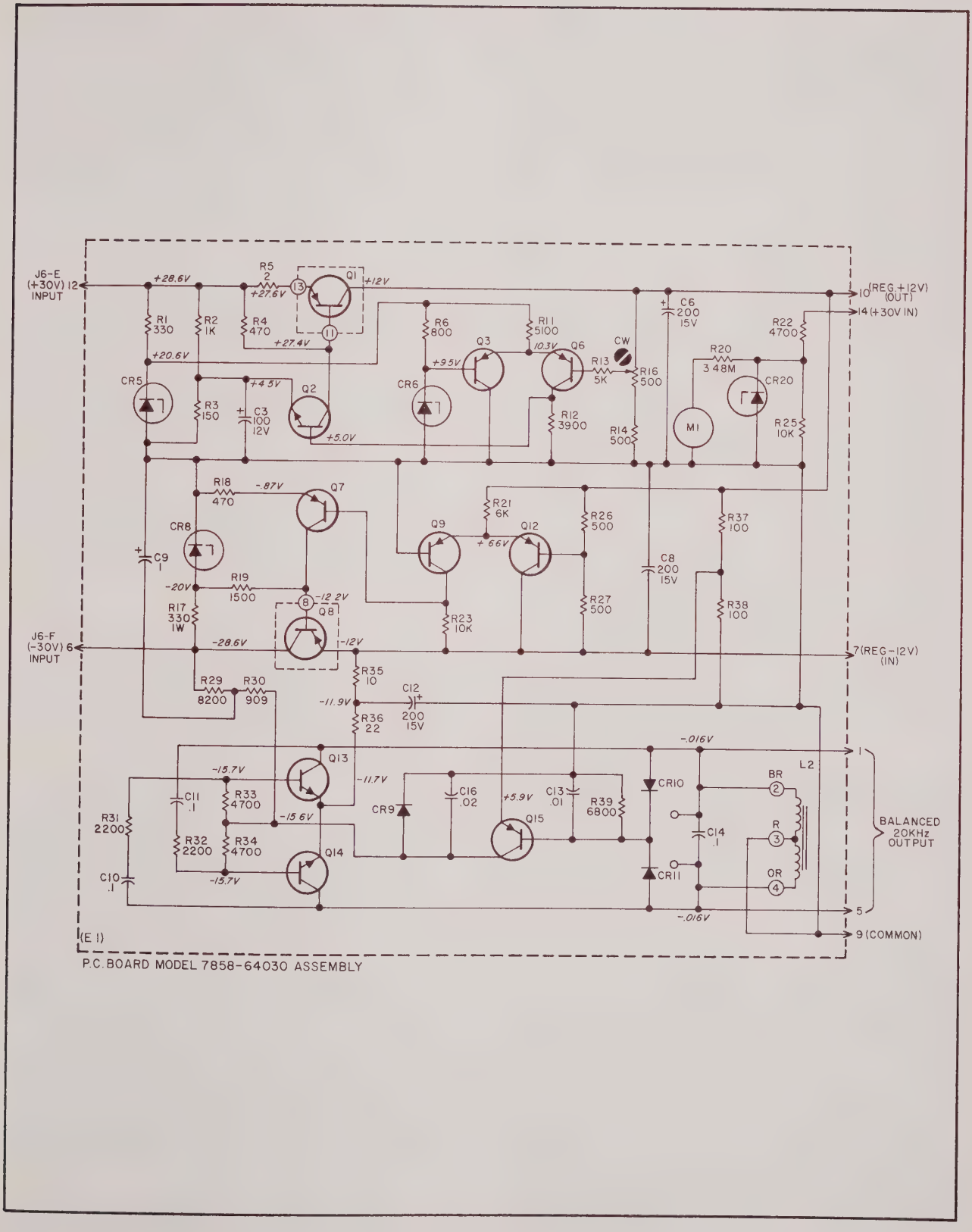


Figure 4-20. Regulator and Oscillator Printed Circuit Board

The plating rate is determined by fixing the voltage with breakdown diode CR20 and establishing a standard current with resistor R20. The remaining factor determining the quantity of mercury plated is the time during which this circuit is energized. Therefore, the length of the mercury column from the starting end is a measure of time in service. R22 is the dropping resistor against which CR 20 regulates. Power from the +30 volt supply operates this meter whenever the motor relay K1 is energized.

4-86. Motor Relay K1 and Timer Marker Assemblies.

4-87. Primarily, motor relay K1 is operated from the +27 Vdc supply through the front panel controls, or by remote control, to turn on the 115 Vac chart drive motor. Also on this line are the timer marker motors B1 and B2. Additionally, the energizing of K1 makes +30 Vdc and -30 Vdc available for the Driver Amplifiers, the marker amplifier operation and the marker amplifier triggering. This protects the pens against drive power when there is no chart motion, and, through the interlock switch, when there is no paper. +27 Vdc for the solenoids of the electrically operated valves and the chart drive speed control is made available by the fourth set of contacts on relay K1. Refer to Figure 4-21.

4-88. The timer marker assembly has two motor driven switches for triggering the left marker pen amplifier once per minute (B1) or once per second (B2). While the synchronous motors both run when the chart drive motor runs, triggering voltage is

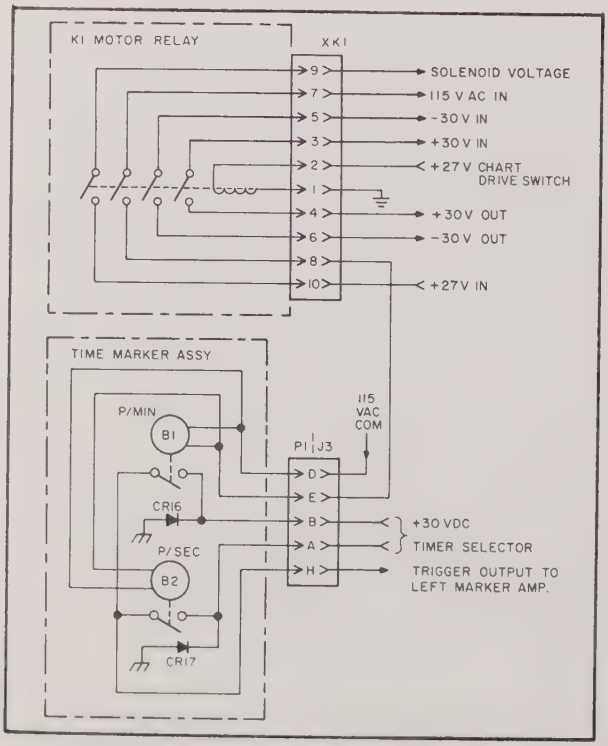


Figure 4-21. Motor Relay and Timer Marker

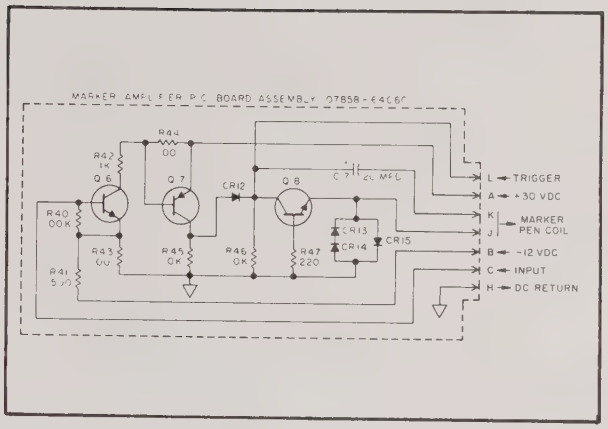


Figure 4-22. Marker Amplifier Schematic

available only to that switch selected at the front control panel or remotely. Diodes C16 and C17 protect the switch contacts from damage due to arcing.

4-89. Marker Amplifiers.

4-90. The left and right marker amplifiers are identical. They are constructed as plug-in printed circuit board assemblies. A schematic diagram which applies to either marker amplifier is shown in Figure 4-22.

4-91. The marker pen motor is a bistable device using a permanent magnet and a coil with a soft iron core. With no coil current the permanent magnet attracts and holds whichever end of the soft iron core is nearest. Current in the coil in one direction has no further effect, but an adequate pulse in the other direction causes the first end of the soft iron to be repulsed and the other end attracted and locked.

4-92. The trigger circuit used for all internal marking functions is comprised principally of capacitor C17 and transistor Q18. When a positive voltage is applied to the trigger terminal, the capacitor C17 is charged through the marker pen coil and diode CR15. The marker pen moves in from the chart edge and assumes a stable condition there. Since the capacitor charging cycle continues without further motion of the pen, a clean leading edge is formed on the chart paper.

4-93. Prior to the incoming trigger, transistor Q18 was without collector voltage and inoperative. During the capacitor charge, Q18 is at cut-off because the voltage drop of about 0.5 volt across CR15 raises the Q18 emitter potential above that of the base which is returned to ground. When CR17 is completely charged, the collapsing field of the pen coil produces a counter electromotive force in a direction tending to keep Q18 cut off. This condition persists as long as the trigger is applied, since a small leakage current in C17 keeps the Q18 emitter slightly positive.

4-94. Note that resistance R46 draws current from the triggering point. When the trigger voltage, is re-

moved, the current in R46 continues because of the charge on C17, but the return circuit for this current is now changed. The current is now being supplied by the capacitor and must flow through the pen coil. Current direction is such as to require the path through CR16 and CR17. The drop across these diodes causes the emitter of Q 18 to be negative by about one volt relative to its base. Q18 thereupon conducts heavily, completely discharging C17 through the pen coil and driving the motor back to its first stable position. At the same time, the circuit has been reset for the next trigger.

4-95. For remote triggering, a positive 1-1/2 volt source is connected to the base of Q16. A voltage gain of 20 is realized in the Q16 and Q17 stages. This applies, through the decoupling diode CR12, approximately the same voltage used for direct triggering, with a similar response.

4-96. Motor Drive and Fuse Assembly Circuits.

4-97. Fuses for the entire system except for Preamplifiers and optional ancillary equipment are found on the motor drive and fuse assembly (see schematic diagram Figure 4-23). The circuits protected by the six slow-blow fuses are as follows:

Fuse	Amperage	Circuit
F1	5	Main 115 Vac Line
F2	8	+30 Vdc Through Motor Relay
F3	8	-30 Vdc Through Motor Relay
F4	0.5	+30 Vdc to 12 Vdc Regulator
F5	0.5	-30 Vdc to 12 Vdc Regulator
F6	3.2	Chart Drive Motor 115 Vac

4-98. Speed selection buttons at the front control panel operate the speed control solenoids K1 through K4A in various combinations to give the desired chart speeds. See Table 4-1 for a table of chart paper speed versus solenoids energized. Note that solenoids K4 and K4A operate together for a speed change of 100.

4-99. Solenoids K5, K6, and K7 operate, and are physically part of, valves which control the air system determining fluid pressure at the pen tip. When the chart motor is turned on K5 is energized to close the vent which otherwise keeps the system air pressure at zero. With only this valve energized, air from the lowest air pressure regulator is supplied to the ink regulators. When the times-ten relay K3 is in the speed combination selected, K7, the medium pressure valve solenoid is also energized, changing the air output connection from the low pressure regulator to the medium pressure regulator. Similarly, if the times-one-hundred pair (K4, K4A) of speed solenoids is in use, valve solenoid K6 is energized connecting in the high pressure regulator. If K6 is energized, K7 has no additional effect.

4-100. PREAMPLIFIER POWER SUPPLY DETAILS.

4-101. The Preamplifier Power Supply acts as an input, output, and power transfer chassis, and supplies dc and ac power for up to eight Preamplifiers.

4-102. Transfer Chassis Operation.

4-103. Figure 4-24 shows the operation of the Preamplifier Power Supply as a transfer chassis. Note that terminals on output connectors J21 through J28 are used for servo reference input with Phase Sensitive Demodulator Preamplifiers such as Model 8806A, and for transducer excitation outputs from Carrier Preamplifiers such as Model 8805A. Connectors J1 through J8 and J11 through J18 include a guard shield sleeve as part of the connector; guard shield theory is discussed in the following paragraphs.

4-104. Guarded Input Circuits.

4-105. The Preamplifier Power Supply includes a guard circuit in the input signal cabling of each channel. This circuit helps maintain the common mode rejection of floating input Preamplifiers such as Model 8803A. The most difficult common mode rejection problem occurs with a high common mode voltage and a signal circuit having unequal source resistances on the two sides of the circuit.

4-106. As shown in Figure 4-25, when the shield is connected to ground, the common mode source causes a current to flow to ground through the two parallel paths R1, C1 in series and R2, C2 in series. In the usual case, C1 is considered equal to C2 so that the reactance of C1 equals the reactance of C2. Both are much greater than R1 or R2. Hence equal currents flow in each RC network as determined by the equal capacitances and the common mode source.

4-107. The equal voltages across R1 and R2, which are unequal resistances, produce a voltage difference between the amplifier input terminals. This is a differential signal, the type the amplifier was designed to amplify. Even if the amplifier had infinite common mode rejection, it would still amplify this signal.

4-108. The common mode voltage will not produce a differential signal if it does not cause a current to flow through R1 or R2. This condition can be met by holding both ends of C1 and C2 at the same common mode voltage. This occurs if the cable shield is tied to the common mode source, often the case or the low side of the transducer (see Figure 4-26). Such a circuit is said to be guarded.

4-109. In the Model 8803A Preamplifier, the guard shield is carried from the rear of the Preamplifier Power Supply chassis through to a "guard box" (a shield box which is inside another shield box and electrically insulated from it). This inner box is on the Preamplifier chassis and surrounds the input circuit.

4-110. The guard shield may also be surrounded by

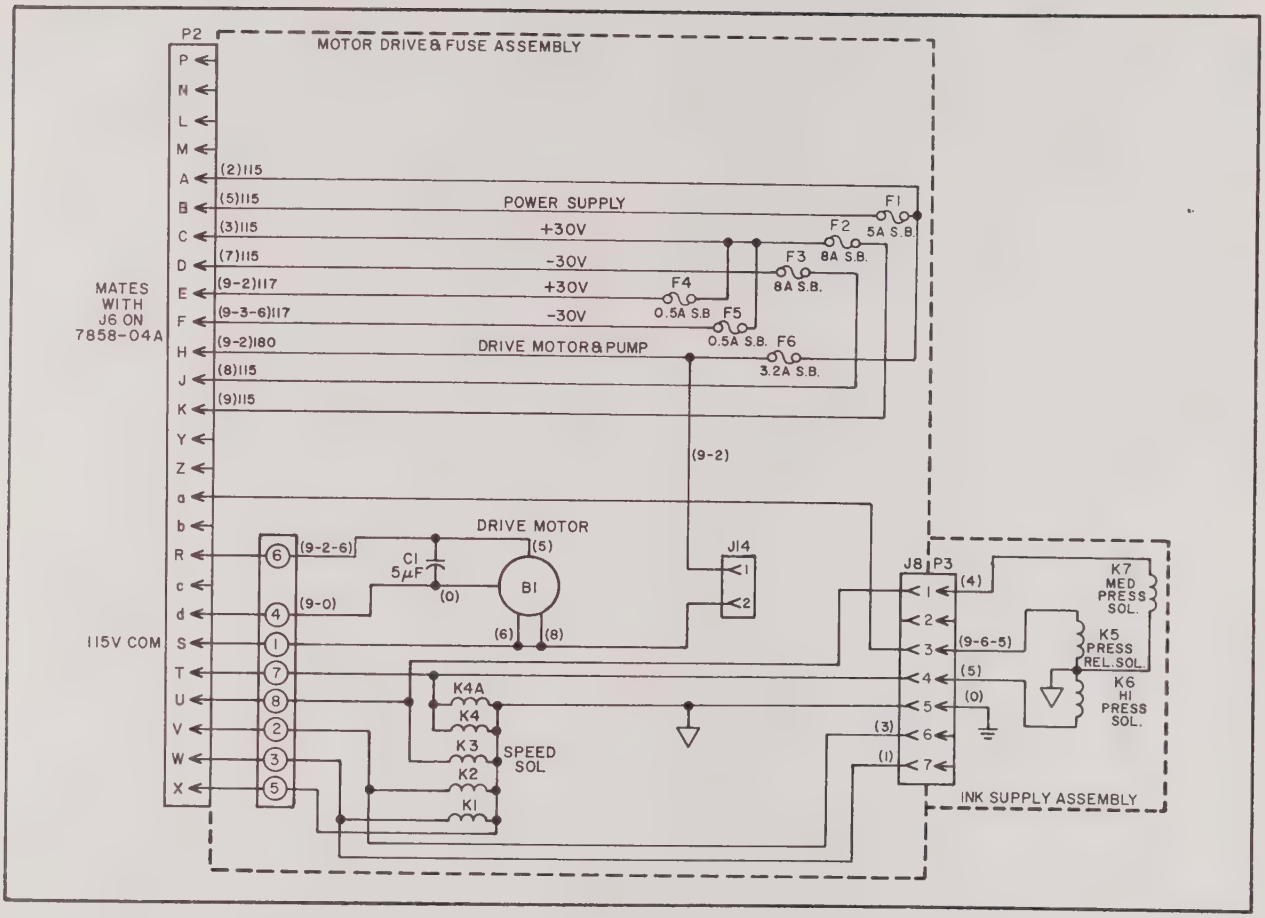


Figure 4-23. Schematic Diagram of Motor Drive and Fuse Assembly

a second, normally grounded shield to prevent a common mode voltage component on the guard shield from interfering with other sensitive circuits. This outer shield is not required in most installations.

4-111. Unregulated +18 and -18 Volt Preamplifier Supplies.

4-112. The unregulated +18 and -18 volt Preamplifier supplies are shown in the block diagram, Figure 4-27, and in the schematic diagram at the rear of this manual. Each supply uses a full-wave, solid-state rectifier circuit, with a single capacitor as filter. The output provides operating power for up to eight Preamplifiers. Line power for these supplies, and for all the other supplies in the unit, enters through input fuse F1 and is applied to the rectifier circuits through the common power transformer T1.

4-113. Unregulated -18 Volt Oscillator Supply.

4-114. The unregulated -18 volt oscillator supply is shown in the block diagram, Figure 4-27, and in the schematic diagram at the rear of this manual. This supply uses a circuit having the same configuration as that of the 18 volt Preamplifier supplies described above. The output provides operating power to the

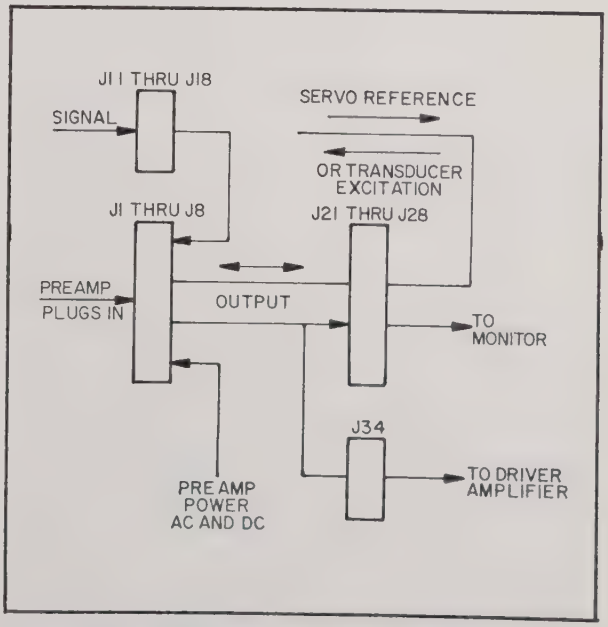


Figure 4-24. Preamplifier Power Supply Operation as Transfer Chassis, Block Diagram.

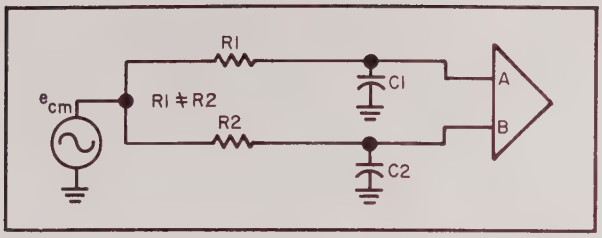


Figure 4-25. Common Mode Signal with Grounded Shield, Unequal Source Resistances, Equivalent Circuit.

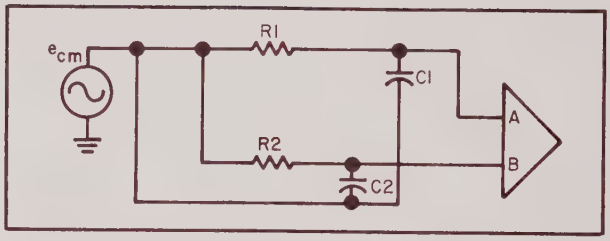


Figure 4-26. Common Mode Signal with Guard Shield, Equivalent Circuit

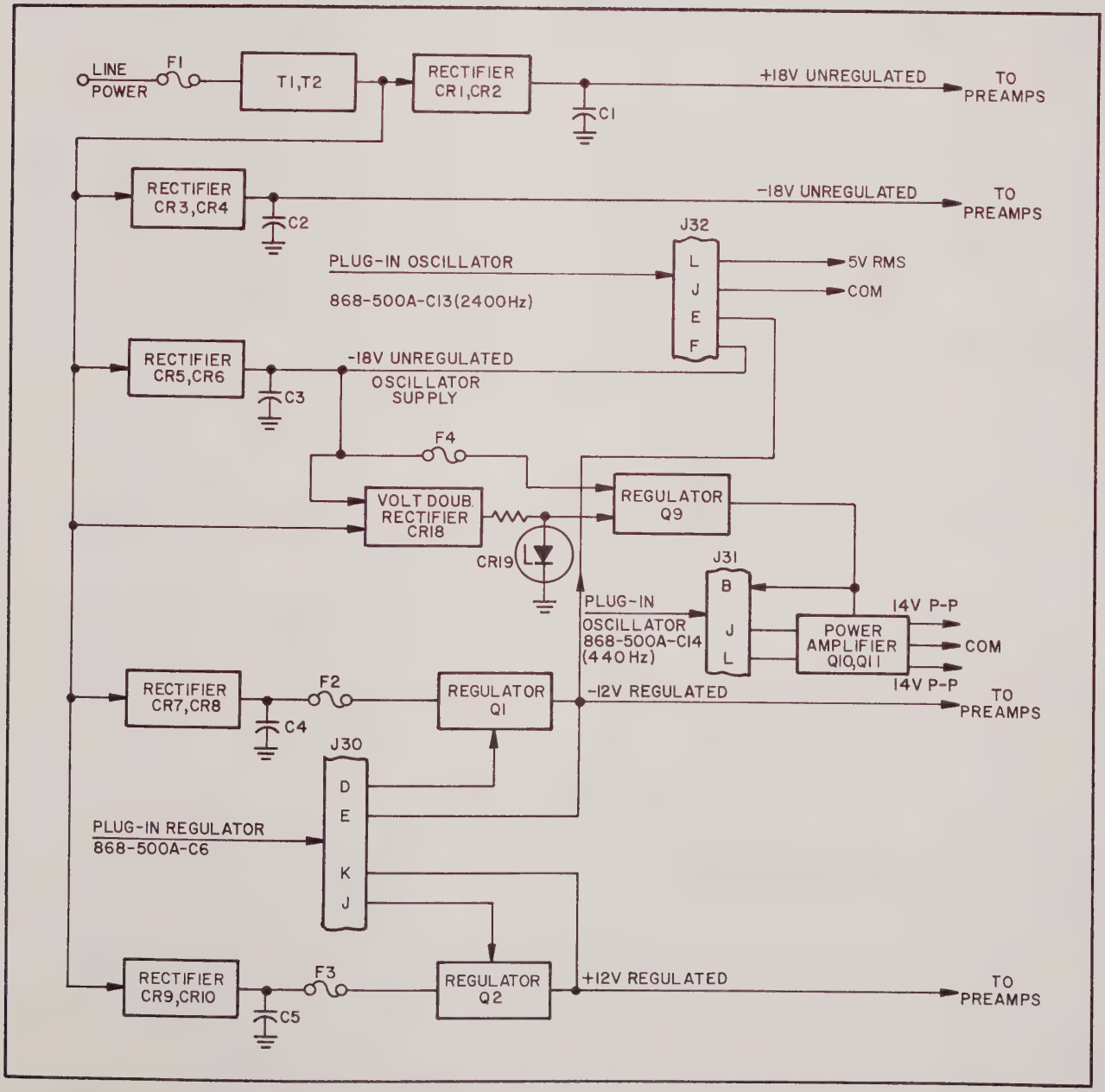


Figure 4-27. Preamplifier power supply, block diagram

plug-in oscillators in J32 and J31, when these are required by the Preamplifiers used in the system.

4-115. Regulated -12 and +12 Volt Preamplifier Supplies.

4-116. The regulated -12 and +12 volt Preamplifier supplies are shown in the block diagram, Figure 4-27, and in the schematic diagram at the rear of this manual. Each supply uses a full-wave, solid-state rectifier, with a single capacitor as filter, for a positive and a negative output of approximately 18 volts. Each output is regulated and applied to all Preamplifiers through a regulator transistor which is under the control of the plug-in regulator circuits discussed in the following paragraph.

4-117. Regulator Plug-In Card.

4-118. The regulator plug-in card (868-500A-C6) is shown in Figure 4-28, and in the schematic diagram at the rear of this manual. The -12 and +12 volt regulated supply is furnished to the Preamplifiers through transistors Q1 and Q2, each of which is controlled by the plug-in card circuits. Both regulated voltages are controlled by the one VOLTAGE ADJUST control R4. One input of differential amplifier Q4, Q5 is maintained at 6.2 volts by breakdown diode CR14; the other input is maintained at a fraction of the -12 volt regulated output, as determined by the setting of R4. If the -12 volt regulated output voltage should vary slightly, this will appear as a change in input signal levels between the inputs to Q4 and Q5. This change is further amplified by Q3, and applied to the series control transistor Q1, with such polarity as to return the -12 volt regulated output toward its original value. The +12 volt regulated line is controlled in the same manner. In this case, one input of the differential amplifier Q7, Q8 is at ground potential, and the other input is held at a value determined by the voltage divider R12, R13. Assuming regulation of the -12 volt line, if the +12 volt output should vary slightly, this will appear as a change in input signal levels at the input to Q7, Q8. This change is further amplified by Q6, and applied to the series control transistor Q2 with such polarity as to return the +12 volt regulated output toward its original value.

4-119. 440 Hz Oscillator Plug-In Card.

4-120. The 440 Hz oscillator plug-in card (868-500A-C14) is shown in the block diagram, Figure 4-29, and in the schematic diagram at the rear of this manual. Oscillations are generated by push-pull oscillator Q12, Q13 at a frequency determined by oscillation transformer T4 and capacitor C15. Thermistors TM1, TM2 provide oscillator stability. Output from T4 drives the power amplifier Q10, Q11. Diodes CR21, CR22 control the amplitude of oscillation at a level determined by breakdown diode CR23. Oscillator

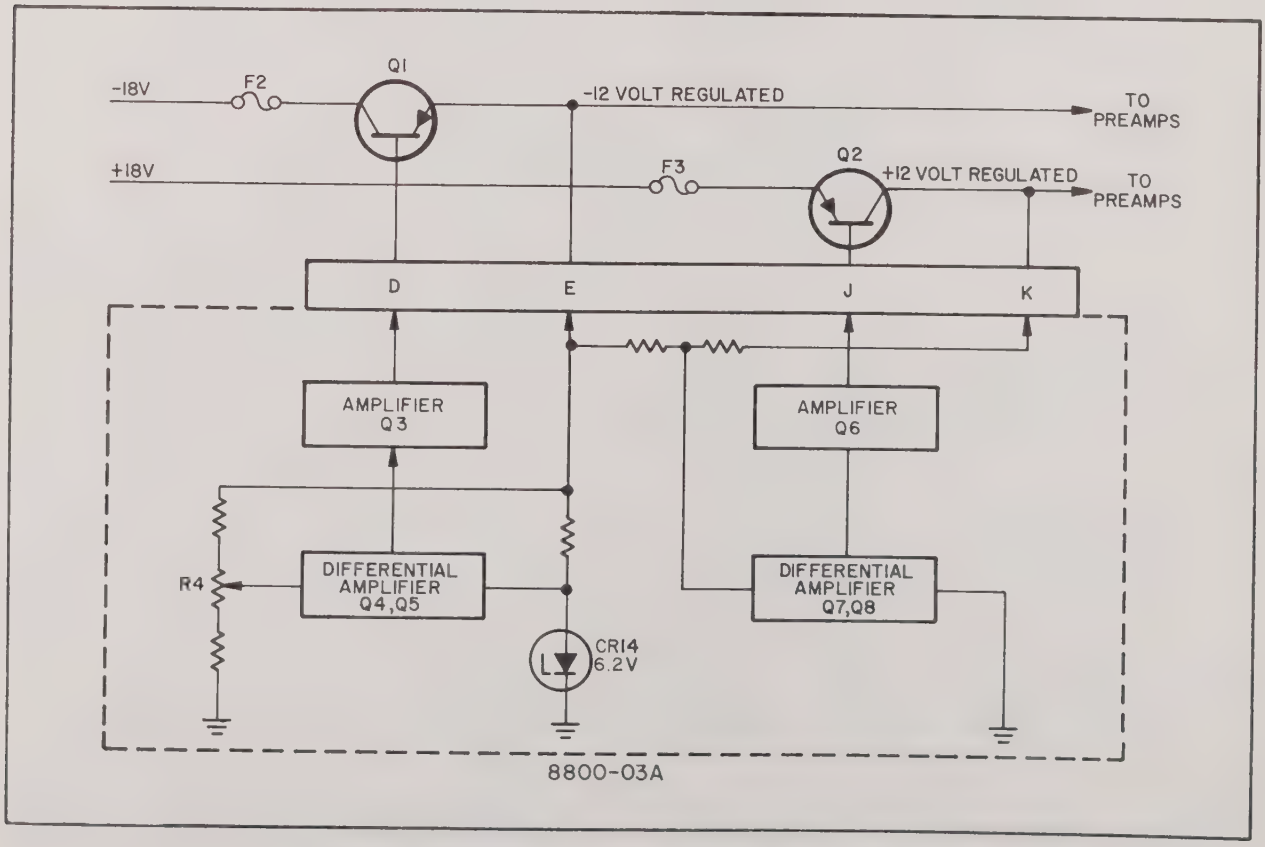


Figure 4-28. Regulator Plug-In Card, Block Diagram

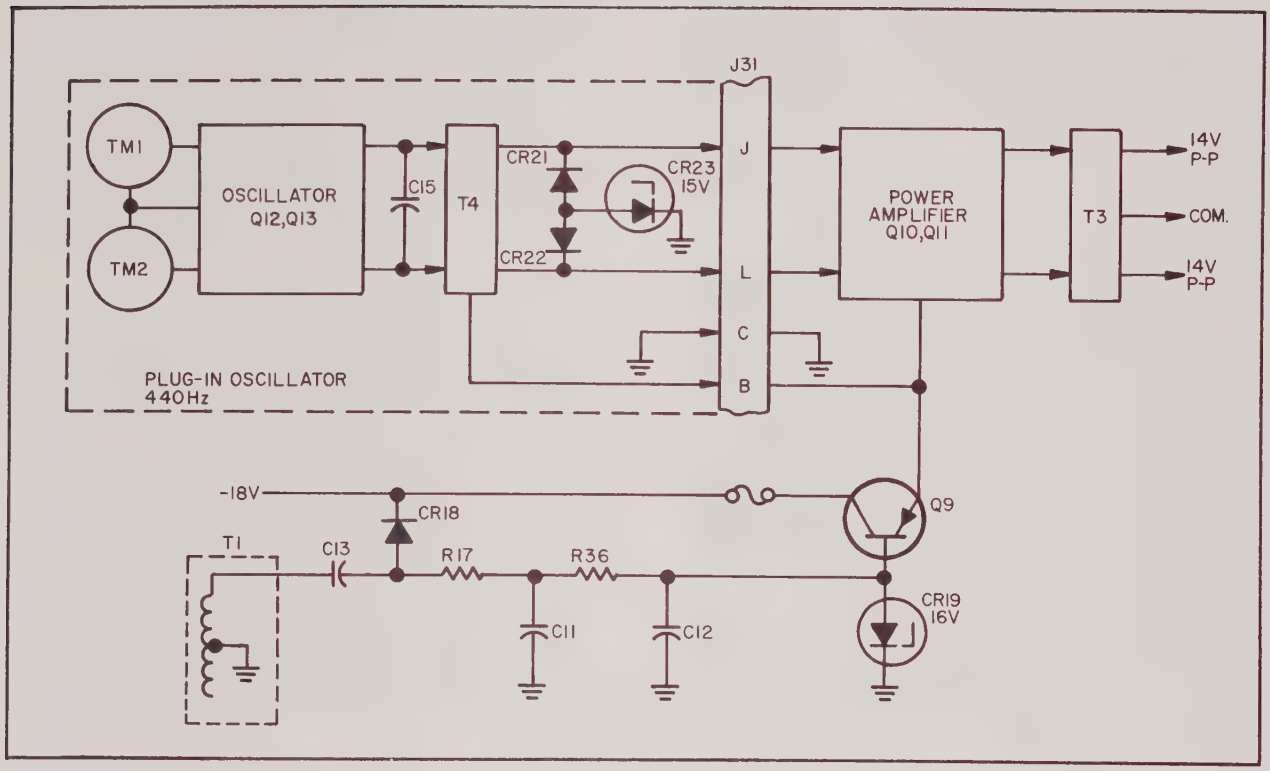


Figure 4-29. 440 Hz Plug-In Oscillator Block Diagram, with Associated Circuits

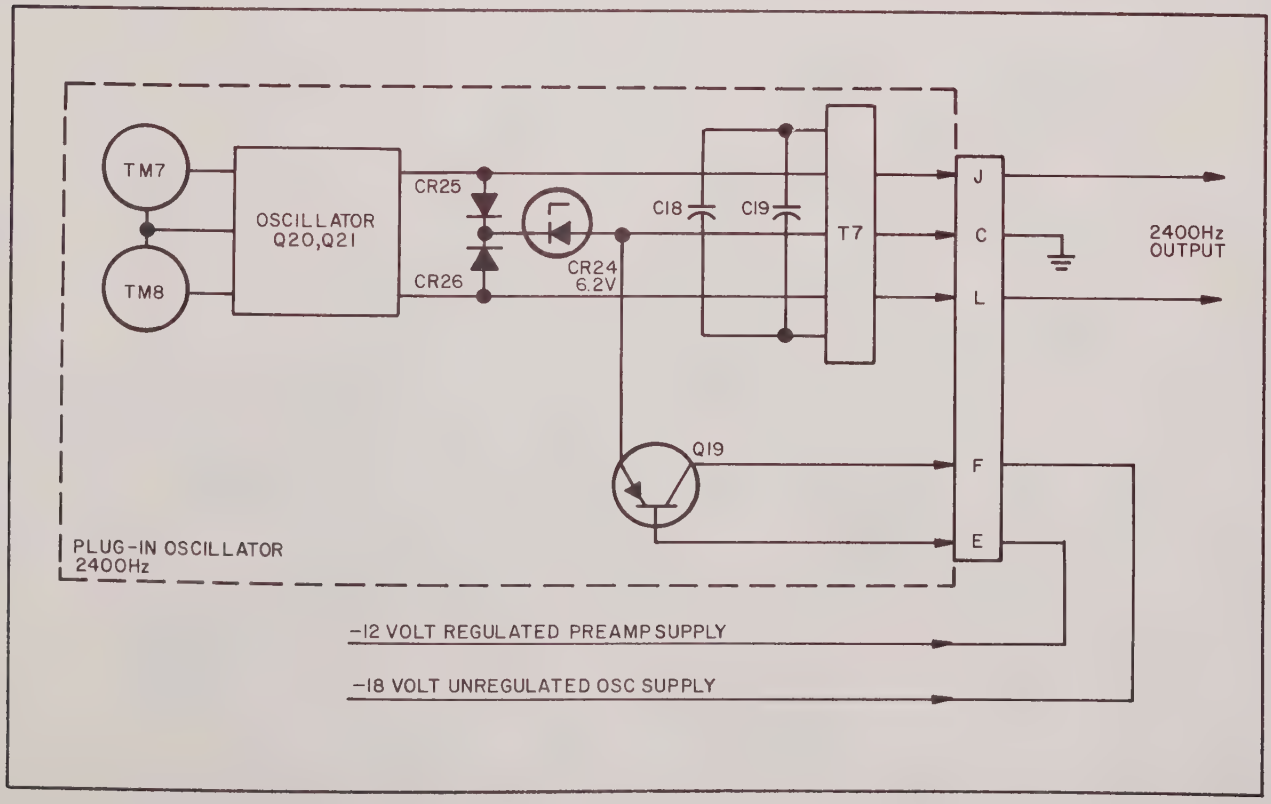


Figure 4-30. 2400 Hz Plug-In Oscillator Block Diagram

power is provided from the -18 volt unregulated oscillator supply line, through regulator Q9. The base of Q9 is held at 16 volts by breakdown diode CR19 as shown in the figure. This base voltage is supplied from the voltage-doubling rectifier C13, CR18, and its following filter, operating from one side of the power transformer T1 and the -18 volt unregulated oscillator supply line.

4-121. 2400 Hz Oscillator Plug-In Card.

4-122. The 2400 Hz oscillator plug-in card (868-500A-C13) is shown in the block diagram, Figure 4-30, and in the schematic diagram at the rear of this manual. Oscillations are generated by push-pull oscillator Q20, Q21, at a frequency determined by oscillation transformer T7 and capacitors C18 and C19 in parallel. Thermistors TM7, TM8 provide oscillator stability. Output from T7 is a balanced ac voltage with respect to ground. This voltage is used to excite the system Preamplifiers. The Preamplifiers re-amplify this excitation for use with transducers. Diodes CR25, CR26 control the amplitude of oscillation at a level determined by breakdown diode CR24. Oscillator power is provided from the -18 volt unregulated oscillator supply line, through regulator Q19, located on the plug-in card. The base of Q19 is held at a regulated -12 volts from the regulated Preamplifier supply, for a regulated supply voltage to Q20, Q21 of approximately -12 volts.

4-123. CHART DRIVE.

4-124. Motor.

4-125. A continuous duty, capacitor start, synchronous motor is used to drive the chart paper through multiple reduction gears. The motor is cushion mounted to ease starting torque and to minimize the transmission of vibrations to the Recorder chassis. For 60 Hz operation, the motor speed is 1800 rpm.

4-126. Chain Belt.

4-127. The toothed motor pulley drives a chain belt which engages a gear at the input of the controllable speed reduction assembly. An initial speed reduction of 5:1 is accomplished in this coupling.

4-128. Controllable Speed Reduction.

4-129. Chart paper speed is varied through the use of a gear train made up of five similar modules. Each module is capable of straight through 1:1 drive when an associated solenoid is energized, or of a speed reduction when the solenoid is not energized. Counting from the driven end, the first module, when not energized, produces a 2:1 reduction; the second, a 4:1 reduction; and each of the remainder, a 10:1 reduction (see Figure 4-31).

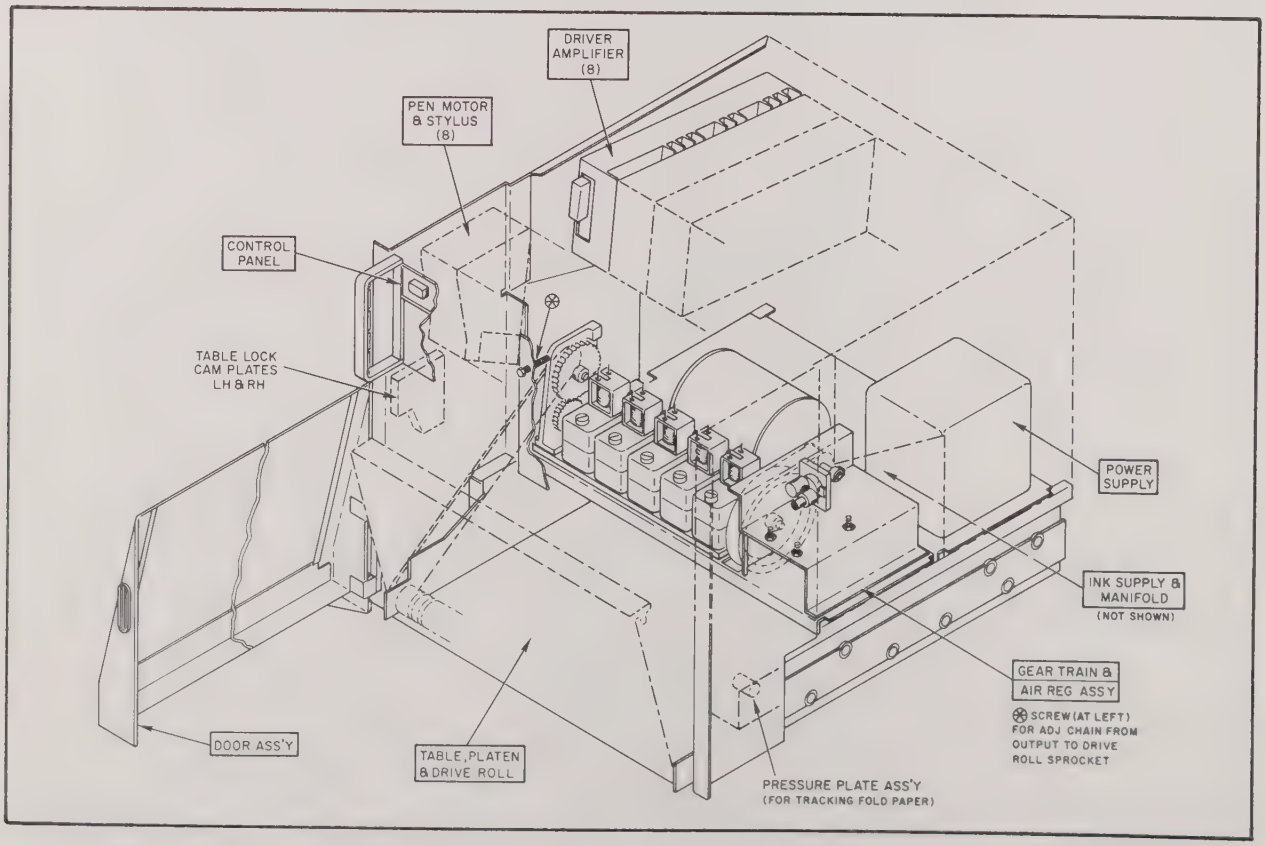

DRIVER AMPLIFIER (8)
PEN MOTOR & STYLUS (8)
CONTROL PANEL
TABLE LOCK CAM PLATES LH & RH
POWER SUPPLY
INK SUPPLY & MANIFOLD (NOT SHOWN)
GEAR TRAIN & AIR REG ASS'Y
⊗ SCREW (AT LEFT) FOR ADJ CHAIN FROM OUTPUT TO DRIVE ROLL SPROCKET
DOOR ASS'Y
TABLE, PLATEN & DRIVE ROLL
PRESSURE PLATE ASS'Y (FOR TRACKING FOLD PAPER)

Figure 4-31. Recorder, Showing Speed Reduction Assembly

4-130. The power flow through a typical gear reduction module is illustrated in Figure 4-32. The input clutch adapter is pinned to the primary shaft and is driven by the torque input. If the solenoid is energized, the entire spring clutch assembly rotates and turns the output clutch adapter. This results in a 1:1 input/output condition. The overriding clutch (miniclutch) on the secondary shaft will automatically disengage, since the output gear C is turning faster than the input gear B.

4-131. When the solenoid power is removed, a pin drops and engages the ratchet teeth on the clutch sleeve. The input clutch adapter ceases to drive the clutch spring within the sleeve. As gear C slows down, the overriding clutch engages. The gear train A, B, C, D begins to operate since the spring clutch allows the output clutch adapter to turn freely in its normal direction. The speed reduction obtained is the product of the A, B ratio (2:1) and the C, D ratio. For various modules the overall speed ratio may be 2:1, 4:1, or 1:1.

4-132. Referring to Figure 4-17, it will be seen that the solenoids which activate the speed changes at various modules are designated K1, K2, K3, K4, and K4A, where K4 and K4A always operate simultaneously to produce a speed change of X100 (two factors of X10). The paper speeds resulting from the activation of various combinations of solenoids are given in Table 4-1.

Table 4-1. Solenoid Activation for Various Paper Speeds

Paper Speeds MM/Sec	Activated Solenoids				
.025	None				
.05	K1				
.1		K2			
.25			K3		
.5	K1		K3		
1.		K2	K3		
2.	K1	K2	K3		
2.5				K4	K4A
5.	K1			K4	K4A
10.		K2		K4	K4A
25.			K3	K4	K4A
50.	K1		K3	K4	K4A
100.		K2	K3	K4	K4A
200.	K1	K2	K3	K4	K4A

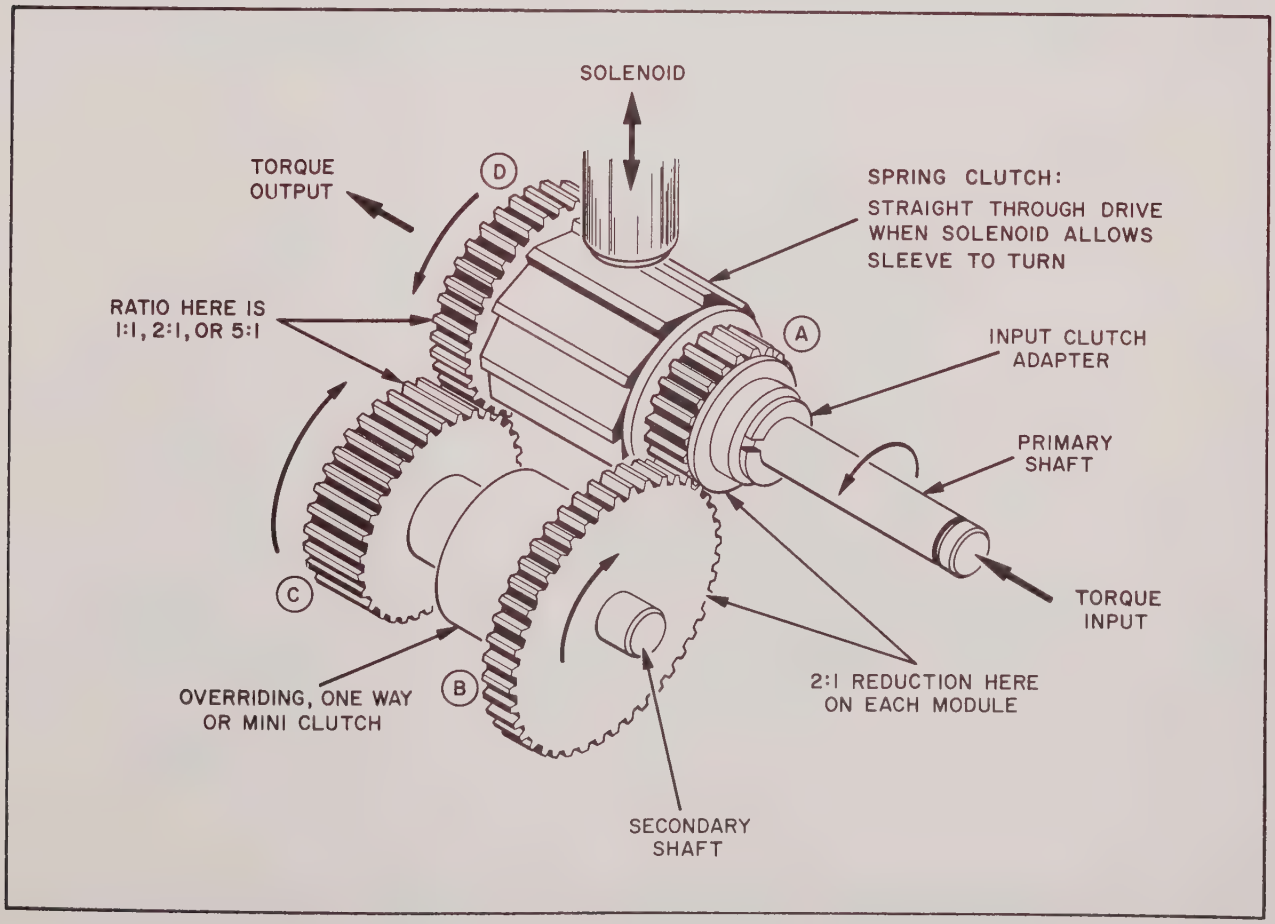


Figure 4-32. Power Flow through Speed Reduction Module

4-133. As can be seen in the photograph in Figure 4-33, the output of the controllable speed reduction gear train is acted upon by three additional gears with an output driving a sprocket for a chain coupling. These gears provide a further reduction of approximately 2.5:1 for systems manufactured for 60 Hz operation. For supply lines of other frequencies, all three gears are factory selected to properly calibrate the chart speed.

4-134. A 1:1 chain drive transfers the torque to the paper drive roll. The drive roll standardizes the motion of the chart paper and has the same function as the capstan in a magnetic tape recorder. Slippage is avoided by a pressure roll which causes the paper to grip the drive roll. Brakes are used to keep the paper flat against the writing platen and paper table at all times.

4-135. Figure 4-35 shows schematically the feed paths of the chart paper. For roll paper the take-up roll is driven from the drive roll through a gear train on the right side of the recorder. Under all conditions, the peripheral speed of the take-up roll is potentially faster than that of the drive roll. However, the take-up roll drive is through a slipping clutch so that the paper is not broken, but slack is eliminated (see Figure 4-34).

4-136. RECORDING FLUID SUPPLY SYSTEM.

4-137. General.

4-138. Ink in a flexible plastic bag, placed under pressure by air at 6 psig surrounding the bag, is fed through a regulator where a selection of air pressures adjusts the ink pressure. The ink then passes through a manifold and valve, through a modulating pump, and into the pen-tubing. Just before the pen tip, pulses of the modulating pump are smoothed by an accumulator damper (see Figure 4-36).

4-139. Air under pressure is supplied by a plunger type pump, run from the chart motor. The air pressure used at the ink regulator is itself determined by one of three air pressure regulators. Air valves, electrically operated, select the appropriate pressure. Additionally, an electrically operated valve exhausts the air system when the chart motor is turned off. Besides releasing the air supply to the ink regulator, this exhaust also allows springs in the manifold to clamp shut the feed to each pen.

4-140. Pressurized Ink Supply Chamber.

4-141. A metal cylinder with a detachable cap is used to hold the ink supply bottle. The supply bottle is rigid plastic externally and contains a flexible plastic

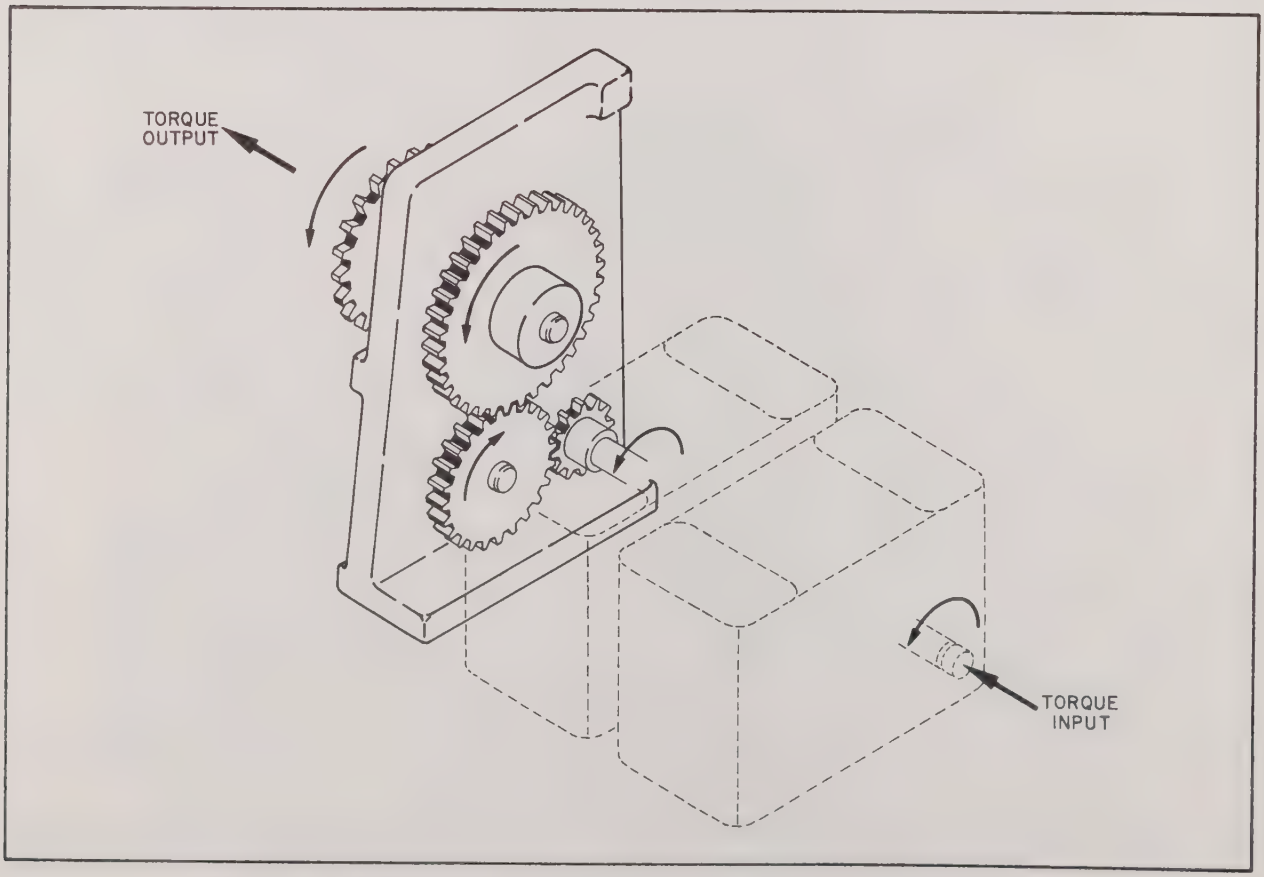


Figure 4-33. Speed Reduction Assembly, Showing Three Gear Output Train

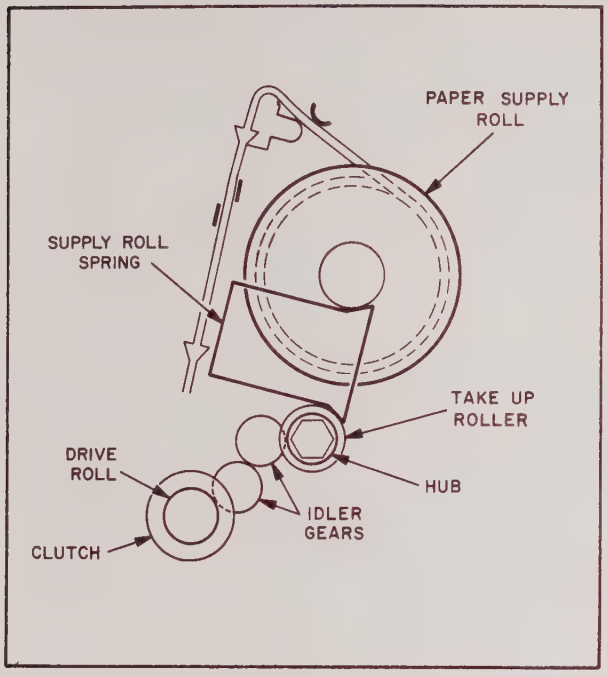


Figure 4-34. Take-Up Roll Drive

bag filled with the writing fluid (see Figure 4-37 and the Air-Ink Schematic in Section VI). A pad in the cylinder cap presses the plastic bottle in so that a hypodermic type tube pierces a central rubber stopper and allows writing fluid to enter the core of the plunger. The flat end of the plunger presses against the stopper to enhance the seal.

4-142. Further inward movement of the bottle causes the plunger to move against the force of the plunger spring. This causes the outer edge of the plastic bottle cap to engage with a seal which allows air under pressure to enter perforations in the bottle cap and to surround the flexible ink bag. Note that the air does not come in contact with the ink.

4-143. Before the insertion of the ink supply bottle, the parts at the right end of the plunger rest between O-rings A and B, sealing the fluid system so that the ink bottle may be changed without loss of ink. When the bottle is fully inserted, the plunger moves to the right and the ports connect the plunger core to the regulator entrance chamber. With the ink bottle removed, air escapes through the fine orifice through which the bottle is pressurized. The escape is so slow that the air pump can maintain the minimum 3.0 psig to operate the ink regulator and to keep open the manifold cut-off valves.

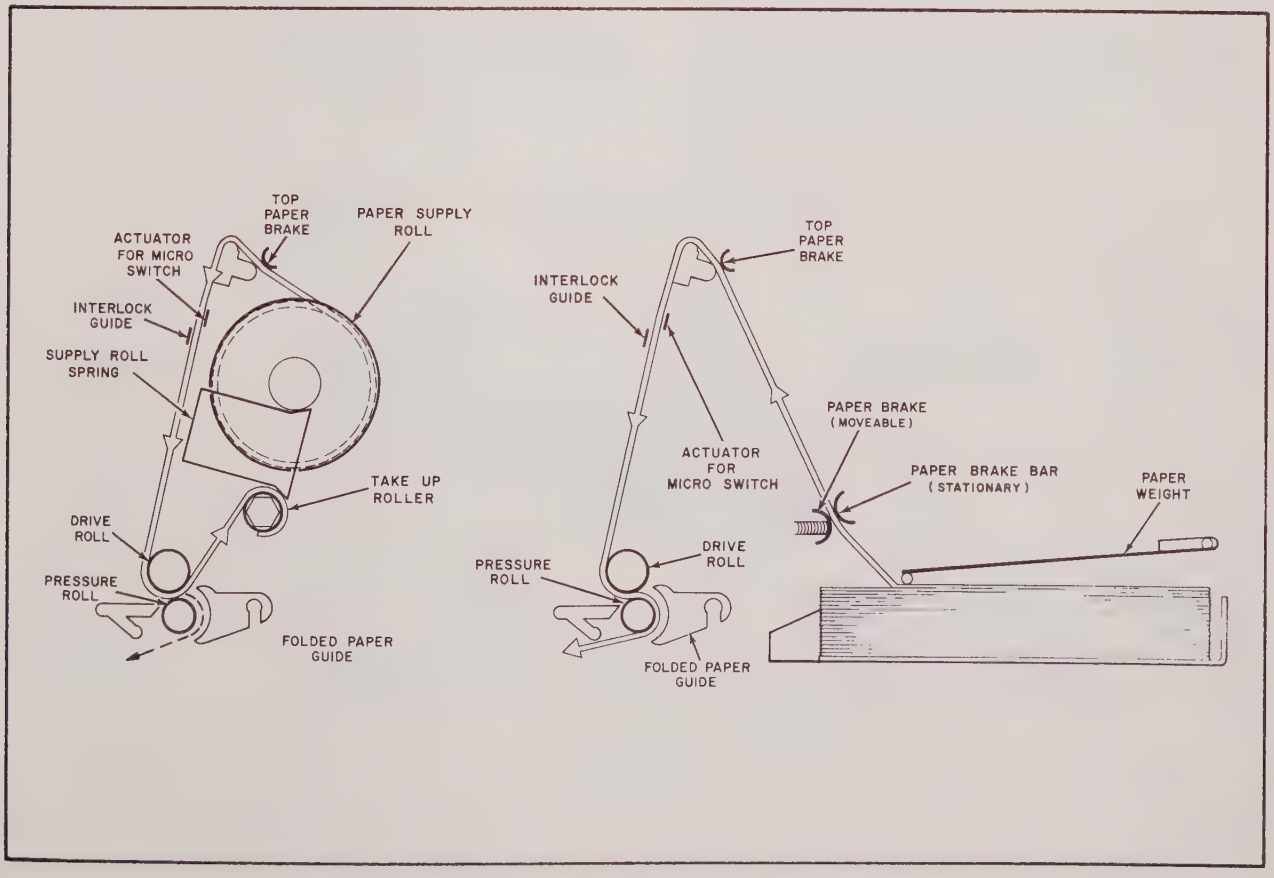


Figure 4-35. Paper Feed Paths, Roll and Z-Fold

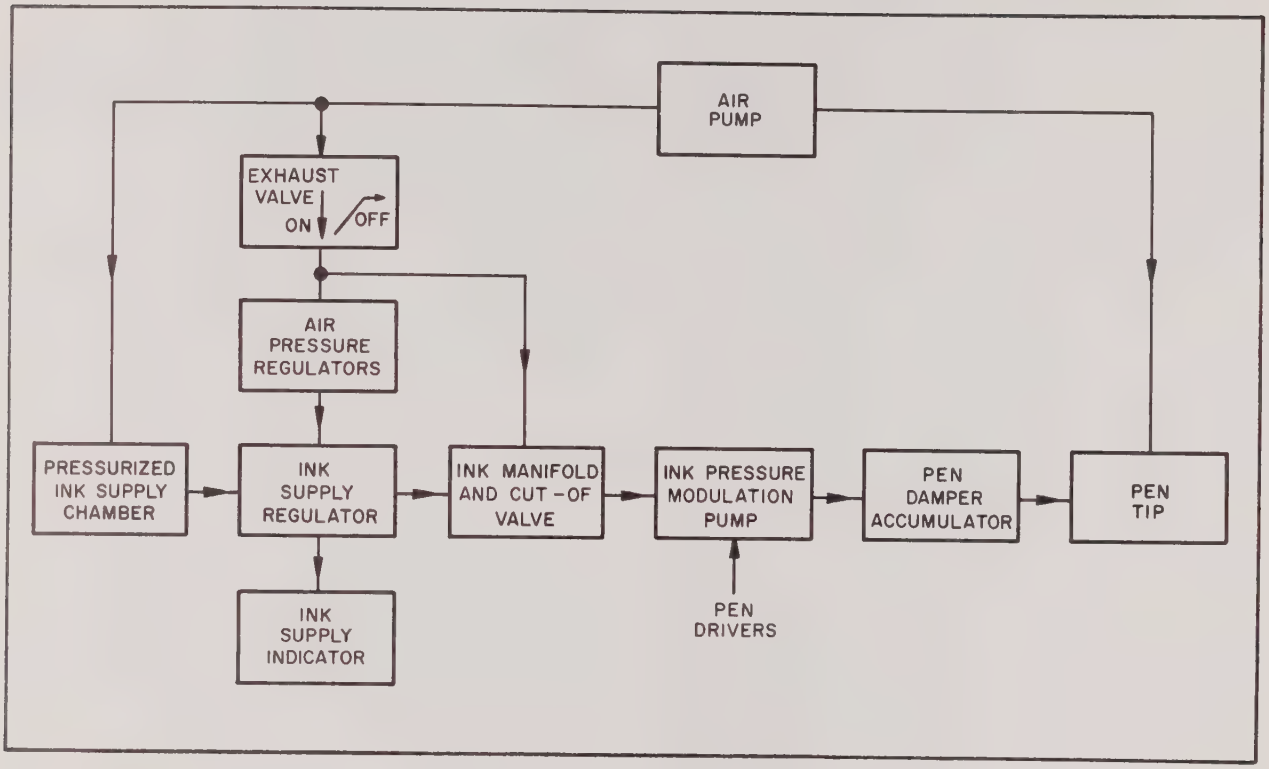


Figure 4-36. Air Ink Flow Chart

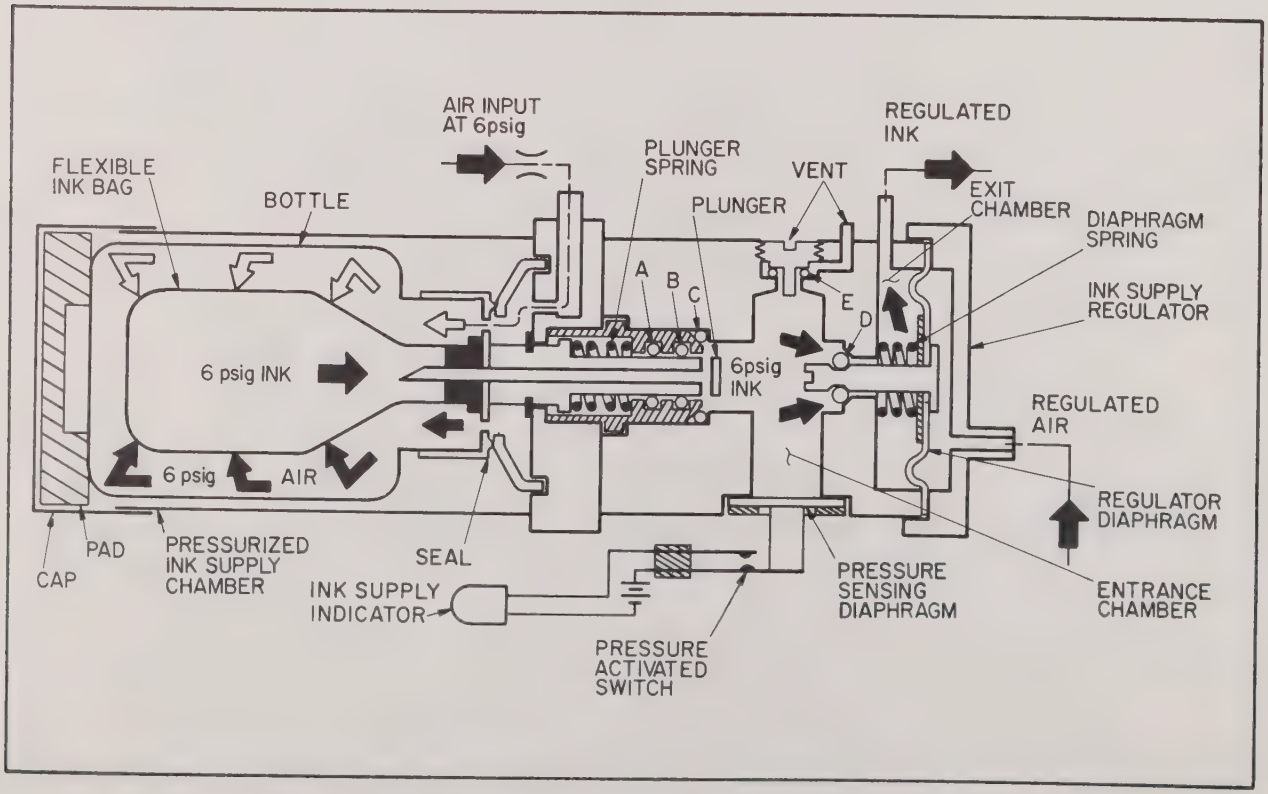


Figure 4-37. Pressurized Ink Supply Chamber and Regulator

4-144. Ink Supply Regulator.

4-145. Fluid reaching the entrance chamber of the ink supply regulator is at the same pressure as the air surrounding the flexible plastic bag, that is, at 6 psig. Note that when the fluid is initially introduced into the system, air can be vented by loosening the plug which engages O-ring E. Also related to the entrance chamber is the ink supply indicator. A slight reduction of pressure at the sensing diaphragm causes sufficient inward motion of the diaphragm to close the switch and light the indicator lamp.

4-146. O-ring D on the regulator plunger forms a seal between the entrance and exit chambers of the regulator. When air is applied on the right side of the regulator diaphragm, the diaphragm moves to the left, compressing the diaphragm spring. This opens a gap at O-ring D and ink flows to the regulator exit chamber under the influence of the 6 psig pressure. In the absence of gross amounts of ink flow from this chamber, pressure increases, forcing back the diaphragm until pressures on each side of the diaphragm are equalized. At this point, the diaphragm spring has moved back the plunger to shut off ink flow at O-ring D. As ink in the exit chamber is used, pressure on this side of the diaphragm reduces until the valve is momentarily opened and the pressure is restored.

4-147. A filter is located at the exit to the ink regulator. This removes from the ink any small particles which might lodge further along in the flow path or at the pen tip.

4-148. Manifold and Cut-Off Valves.

4-149. The ink manifold consists of a center-fed stainless steel tube with an outlet for each of the eight signal pens and two marker pens. A shut-off valve is used for each pen. Valve construction is as follows: the stainless steel tube G, which feeds from the manifold, is plugged in a narrowed-down section (plug is shown as a ball H in Figure 4-38) and ports F, F' are drilled on each side of the obstruction. A shaped plastic tube section J is slipped over the narrowed metal section and ports. When the valve is on, ink flows around the obstruction by going out one port and in the other. A two part yoke K, shown simplified in this pictorial, is pressed down by the leaf spring L to hold the flexible tubing K against the most centrally located port F', shutting off ink flow. The bottom of the yoke rests against a flexible rubber tube M running the length of the manifold. When the solenoid operated air valve K5 is turned on, the rubber tube M is inflated and lifts the yoke K at each valve. This opposes the spring L and allows the flexible plastic tubing J to spring up, opening ports F, F'. A manually operated screw is also provided so that the ink supply to any pen can be shut off by preventing the related yoke from rising.

4-150. Ink Pressure Modulation Pumps.

4-151. Each of the signal pens (but not the marker pens) has in its ink supply line a small modulation pump. Within the pump a piece of flexible plastic tubing carrying the ink is pinched between a small

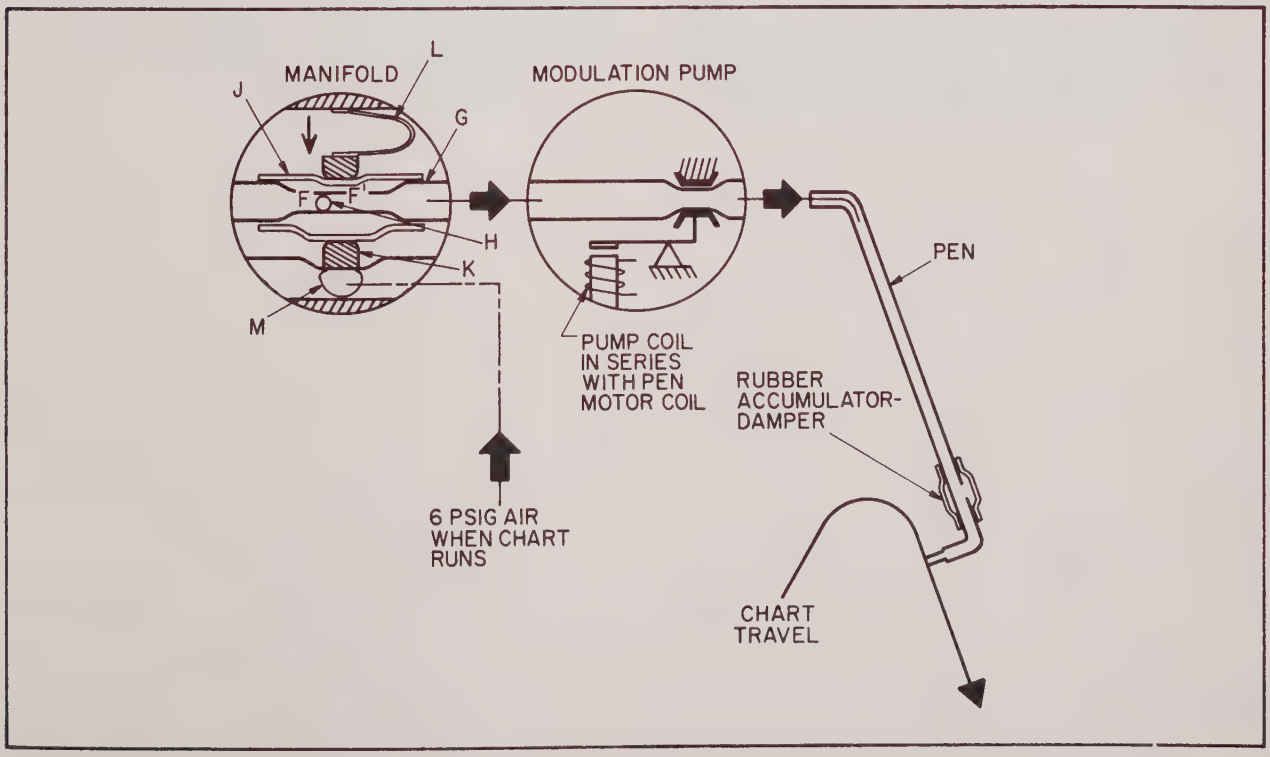


Figure 4-38. Typical Manifold Shut-Off Valve, Modulation Pump and Pen

fixed anvil and a movable pressure plate. This plate is attached to a lever which is activated by an electromagnet such as is found in a small electric relay. The coil of the magnet is connected in series with the pen motor coil so that whenever power is applied to move the pen, the ink pressure is increased. The electromagnet is not sensitive to the direction of the current through its coil, so that there is an increase in ink pressure regardless of the direction in which the pen is about to move. In this way, ink pressure at the pen keeps pace with the writing speed; i. e., the faster the pen moves, the faster the ink flows. This helps maintain a constant line width.

4-152. Accumulator Damper.

4-153. The accumulator damper is a small, specially shaped (rubber) tube situated over a hole in the stainless steel pen tubing close to the pen tip. By expanding to accept ink when the pressure increases, the accumulator smooths, but does not eliminate, pulses generated by the pinch pump. It also anticipates the pulse from the pinch pump by supplying ink to the pen tip when the tip has accelerated across the chart paper before the ink pressure pulse has reached it. When the pen is writing at great amplitudes and high frequencies, the accumulator also absorbs much of the pressure variation caused by centrifugal force acting upon the column of ink in the pen tubing.

4-154. Air Pump.

4-155. An eccentric on the chart drive motor shaft drives a plunger in and out of a cylinder to pump air for the writing fluid pressurizing system. The pump has a small felt input filter and input and output check valves. The pump output pressure does not rise above 6 psig because the compression ratio is so chosen that if, at the end of the stroke, pressure reaches 6 psig, then on the back stroke, the pressure will not fall below atmospheric pressure. Under this condition, the input check valve remains closed and no additional air enters.

4-156. Air Regulators and Selection Valves.

4-157. When the chart motor is operating, the exhaust solenoid is energized, closing its vent port and directing air from the pump, at 6 psig, to all three air pressure regulators (see Figure 4-38). These are miniature diaphragm-type regulators, factory set for output pressures of 0. 4, 1. 0, and 3. 0 psig. (Readjustment over the life of the equipment is not normally anticipated.)

4-158. When one of the lowest three chart speeds is used, only one electrically operated valve, K5, is energized, so that pressure from the lowest air regulator is delivered to the writing fluid regulator. When the X10 speed reduction module is energized, so also is electrically operated valve K7. This applies air from the medium air regulator to the fluid regulator. When speeds are used which require the operation of the X100 speed reduction module, electrically operated valve K6 is energized and the fluid regulator receives the high regulated air pressure. These pressure variations accommodate the ink pressure to the pen writing speed.

4-159. Electrically operated valve K5 is de-energized when the chart motor is turned off. This disconnects air pressure from the regulator and manifold lines and bleeds it off through a small orifice. Pressure will normally be retained in the ink supply chamber for some hours, eliminating start-up delays under frequent stop-start conditions.

SECTION V
MAINTENANCE

Please return card in front of manual so we can supply maintenance information for your Fluid Recorder System.

SECTION VI
ILLUSTRATED PARTS BREAKDOWN

6-1. INTRODUCTION.

6-2. This section lists and illustrates the parts composing the 7858A and 7878A INK Recorder Systems, and is used for identification and requisitioning of parts covered by this manual.

6-3. This section is divided into major sub-sections for a complete breakdown of a Major Assembly. Each sub-section will contain a Group Assembly Parts List with illustrations, a Numerical Index and a Reference Designation Index of all parts in that sub-section. Each major sub-section will be tabbed for convenient location.

6-4. GROUP ASSEMBLY PARTS LISTS.

6-5. This section divides the equipment into major assemblies, sub-assemblies and detail parts. This information is listed in columns under the following headings:

a. FIGURE AND INDEX NUMBER. This column contains the number of the figure in which the item appears and the index number of the specific item shown on the figure.

b. PART NUMBER. A number assigned to an item for the purpose of identification. This may be a number assigned by the vendor or Hewlett-Packard. When a part does not have a part number, the term "Reference" appears in the part number column.

c. DESCRIPTION. This column contains the name and description of the item called out, and when applicable, a vendor's code (in parentheses) following the description. For name and address of vendor, refer to the list of Vendors' Codes. Items having a Hewlett-Packard or Sanborn Division part number will not have a vendor's code. The breakdown is prepared in disassembly order with attaching parts labeled and immediately following the parts they attach. An indention of a part in this column indicates the relationship of that part to the next higher assembly. For example: Indention of an item in column three indicates it is part of the immediate preceeding next higher column two assembly, excluding attaching parts. The reference in this column to another figure and separate breakdown will appear for major sub-assemblies. All sub-assemblies will refer back to their NHA, next higher assembly.

d. UNITS PER ASSEMBLY. The number of units required for each next higher assembly. Unspecified numbers of units are indicated by "AR" (as required). Items listed for reference are indicated by "Ref."

6-6. NUMERICAL INDEX. This index lists parts of a major sub-section under the following headings:

a. PART NUMBER. Each part number listed in the group assembly parts list is arranged in alphabetical and numerical order in the numerical index. Part number arrangement left to right, one position at a time. The order of precedence in beginning the part number on the extreme left hand (first) position of the part numbers is as follows:

(1) Letters A through Z
(2) Numerals 0 through 9

The order of precedence in continuing the part number arrangement on the second and succeeding positions of the part number from left to right is as follows:

(1) Space (blank column)
(2) Diagonal (slash /)
(3) Point (period .)
(4) Dash (--)
(5) Letters A through Z
(6) Numerals 0 through 9

NOTE

Alphabetical O's are considered numerical zeros.

b. FIGURE AND INDEX NUMBER. All figure and index numbers will be shown for all parts except hardware. Hardware (screws, washers, nuts, and rivets, etc.) will show the first occurrence only of such parts in the Group Assembly Parts List.

c. QUANTITY PER ARTICLE. The number of units required for one complete Major Assembly.

6-7. REFERENCE DESIGNATION INDEX.

6-8. The Reference Designation Index provides rapid cross referencing between schematic wiring diagrams contained in this manual and the exploded views shown in the Group Assembly Parts List. The Reference Designation Index lists information under the following columns:

a. REFERENCE DESIGNATION. This column lists in alpha-numerical order all Reference Designations.

b. FIGURE AND INDEX NUMBER. The figure and Index Number of each part.

c. PART NUMBER. The part number of each part.

6-9. All Reference Designators used in this breakdown are per MIL-STD-16 using the Unit Numbering method.

6-10. HOW TO USE THIS ILLUSTRATED PARTS BREAKDOWN.

a. To completely identify any part, both its part number and its proper nomenclature should be known. This information can be obtained from the various areas of this manual as follows:

1. If the part number is known, locate the part in the Numerical Index. The figure and index number given in the adjacent column refers to its position in the Group Assembly Parts List.

2. If the Reference Designation is known, locate the part in the Reference Designation Index. The figure and index number listed in the adjacent column refers to its position in the Group Assembly Parts List.

6-11. ABBREVIATIONS.

6-12. Abbreviations will be per MIL-STD-12 and per Table 6-1.

6-13. ORDERING VENDOR ITEMS.

a. When the part number listed is not a Hewlett-Packard part number, a code, which is obtained from Cataloging Handbook H4-1, which denotes the vendor from whom the part can be procured, is shown in the description column.

6-14. The following is a list of manufacturers, their codes and addresses as found in H4-1, and used in this catalog:

Vendor Code	Vendor Name and Address
(To be supplied at a later date)	

Table 6-1. Abbreviations

ABBREVIATIONS *

A	= amperes	fil hd	= fillister head	n	= nano (10^{-9})	rot	= rotary
ACC	= accessories	flm	= film	NC	= normally closed		
AFC	= automatic frequency control	FR	= front	Ne	= neon	s-b	= slow-blow
Al	= aluminum	fwd	= forward	NETWRK	= network	scon	= semiconductor
AMP	= amplifier	fxd	= fixed	Ni Pl	= nickel plate	Se	= selenium
as ord	= as ordered			NO	= normally open	sect	= section(s)
		G c/s	= gigacycles per second (see G Hz)	NPN	= negative positive negative	SEMS	= machine screw with washer
Be Cu	= beryllium copper			NPO	= negative positive zero (zero temperature coefficient)	SEQ	= sequential
BFO	= beat frequency oscillator	Ge	= germanium			Si	= silicon
bh	= binder head	GEN	= generator	nsr	= not separately replaceable	sil	= silver
bp	= bandpass	G Hz	= gigacycles per second			sl	= slide
brs	= brass	gl	= glass	obd	= order by description	SPDT	= single-pole double-throw
		grd	= ground(ed)	od	= outside diameter		
c/s	= cycles/second (see Hz)			ov hd	= oval head	spl	= special
CALIB	= calibration	h	= henry(ies)	ox	= oxide	SPST	= single-pole single-throw
ccw	= counterclockwise	hex	= hexagonal				
cd pl	= cadmium plate	Hg	= mercury	pc	= printed circuit board	sst	= stainless steel
cer	= ceramic	Hz	= cycle per second	PEMS	= circular press fitted nut	SWTCH	= switch
ch	= channel			pF	= picofarad (10^{-12} farads)		
cmo	= cabinet mount only	impg	= impregnated	PH	= phone	Ta	= tantalum
coef	= coefficient	incd	= incandescent	ph brz	= phosphor bronze	td	= time delay
com	= common	ins	= insulation(ed)	Phl hd	= Phillips head	Ti	= titanium
comp	= composition	ips	= inches per second	piv	= peak inverse voltage	tog	= toggle
conn	= connector			pk	= peak	tol	= tolerance
CRT	= cathode-ray tube	k, K	= kilo (1000)	PNL	= panel	trim.	= trimmer
cw	= clockwise	Kc, k c/s	= kilocycles (see k Hz)	PNP	= positive negative positive	twt	= traveling wave tube
		KEPS	= hex rut with lockwasher	poly	= polystyrene		
dB	= decibel	k Hz	= kilocycles/second	por	= porcelain	μor U	= micro (10^{-6})
dep C	= deposited carbon			pos	= position(s)	μA	= microamperes
DISP	= display	lin	= linear taper	pot	= potentiometer	μF	= microfarads
DPDT	= double-pole double-throw	lkwash	= lockwasher	pp	= peak-to-peak	μV	= microvolts
DPST	= double-pole single-throw	log	= logarithmic taper	PREAMP	= preamplifier		
		lp flt	= low-pass filter	prec	= precision (temperature coefficient, long term stability, and/or tolerance)	V	= volt(s)
EIA	= tubes or transistors meeting Electronic Industries Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by stock numbers	m	= milli (10^{-3})			vac	= vacuum
		mA	= milliamperes			Vacw	= volt(s) alternating current working
		mam	= milliammeter				
		M	= mega (10^{6})			var	= variable
		M c/s	= megacycles (see M Hz)	pt	= point	Vdcw	= volt(s) direct current working
		met flm	= metal film				
		mfr	= manufacturer	rec	= recorder		
		mH	= millihenry	rect	= rectifier	W	= watt(s)
elect	= electrolytic	M Hz	= megacycles/second	rev	= reverse	w/	= with
encap	= encapsulated	minat	= miniature	rf	= radio frequency	w/o	= without
		mom	= momentary	rh	= round head	wiv	= reverse working voltage
F	= farad(s)	mtg	= mounting	rmo	= rack mount only		
fet	= field effect transistor	mV	= millivolt	rms	= root-mean-square	ww	= wirewound
fh	= flat head	mW	= milliwatt			Ω	= ohm
FIG	= figure	my	= mylar® (Dupont de Nemours)				

* Electric Accounting Machines (EAM) capitalize all abbreviations

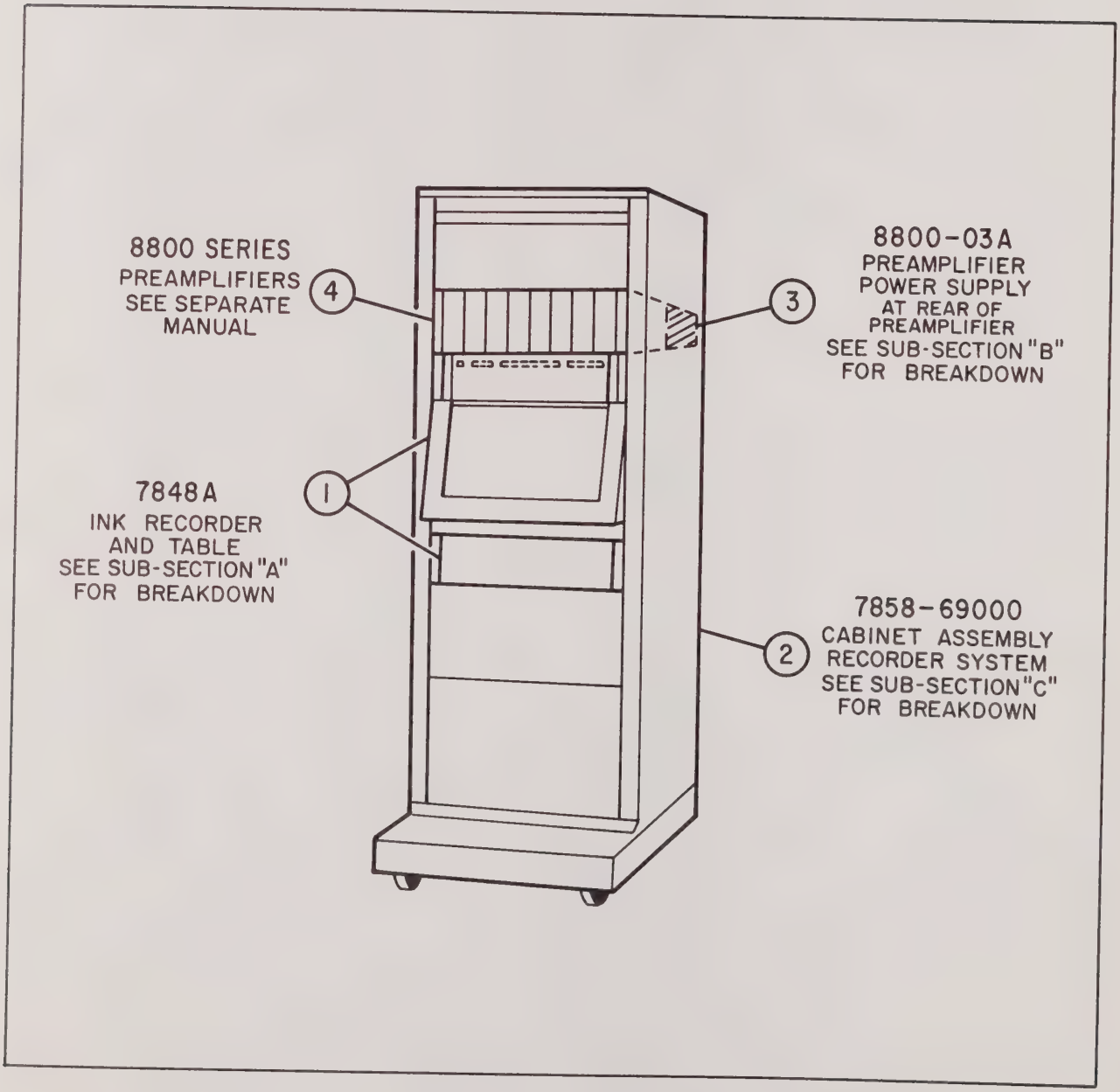


Figure 6-1. Eight Channel Fluid Recorder System, 7858A

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6-1	7858A	EIGHT CHANNEL FLUID RECORDER SYSTEM (see Figure 6-1).	1	
-1	7848A	. OSCILLOGRAPHIC INK RECORDER, Eight Channel (see Sub-section "A" for breakdown)	1	
-2	7858-69000	. CABINET ASSEMBLY, Recorder System (see Sub-section "C" for breakdown).	1	
-3	8800-03A	. PREAMPLIFIER POWER SUPPLY (see Sub-section "B" for breakdown)		
-4	8800	. PREAMPLIFIER ASSEMBLY, 8801A through 8809A (see separate Manual)	Ref.	

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A1-	7848A	OSCILLOGRAPHIC INK RECORDER, Eight Channel (see Figure 6-1-1 for NHA)	Ref.	
-1	07850-62000	. DRIVER AMPLIFIER ASSEMBLY (see Figure 6A2 for breakdown)	8	
-2	07850-63000	. CONTROL PANEL ASSEMBLY (see Figure 6A4 for breakdown)	1	
		(ATTACHING PARTS)		
	838-8	. SCREW, Shoulder	2	
	0590-0439	. STOP NUT	2	
		---*---		
-3	07858-61020	. DOOR ASSEMBLY, Front (see Figure 6A5 for breakdown)	1	
-4	07858-67000	. MOTOR & SPEED CHANGE W/AIR REGULATOR (see Figure 6A6 for breakdown)	1	
		(ATTACHING PARTS)		
	2510-0041	. SCREW, Machine 8-32 x 1/4 SEMS	4	
	2190-0747	. WASHER, Flat No. 8		
		---*---		
-5	Reference	. GALVANOMETER BANK ASSEMBLY (see Figure 6A9 for breakdown).	1	
		(ATTACHING PARTS)		
	2680-0055	. SCREW, Machine, 10-32 x 1/2 SEMS	4	
		---*---		
-6	07858-64000	. POWER SUPPLY ASSEMBLY (see Figure 6A14 for breakdown).	1	
		(ATTACHING PARTS)		
	2510-0041	. SCREW, Machine 8-32 x 1/4 SEMS	4	
		---*---		
-7	07858-67040	. INK SUPPLY ASSEMBLY (see Figure 6A13 for breakdown)	1	
-8	07858-68000	. TABLE ASSEMBLY (see Figure 6A17 for breakdown)	1	
-9	Reference	. MAIN FRAME & BASE ASSEMBLY, (see Figure 6A19 for breakdown).	1	
-10	07858-61250	. FOLDED PAPER DRAWER ASSEMBLY (see Figure 6A19 for breakdown)	1	

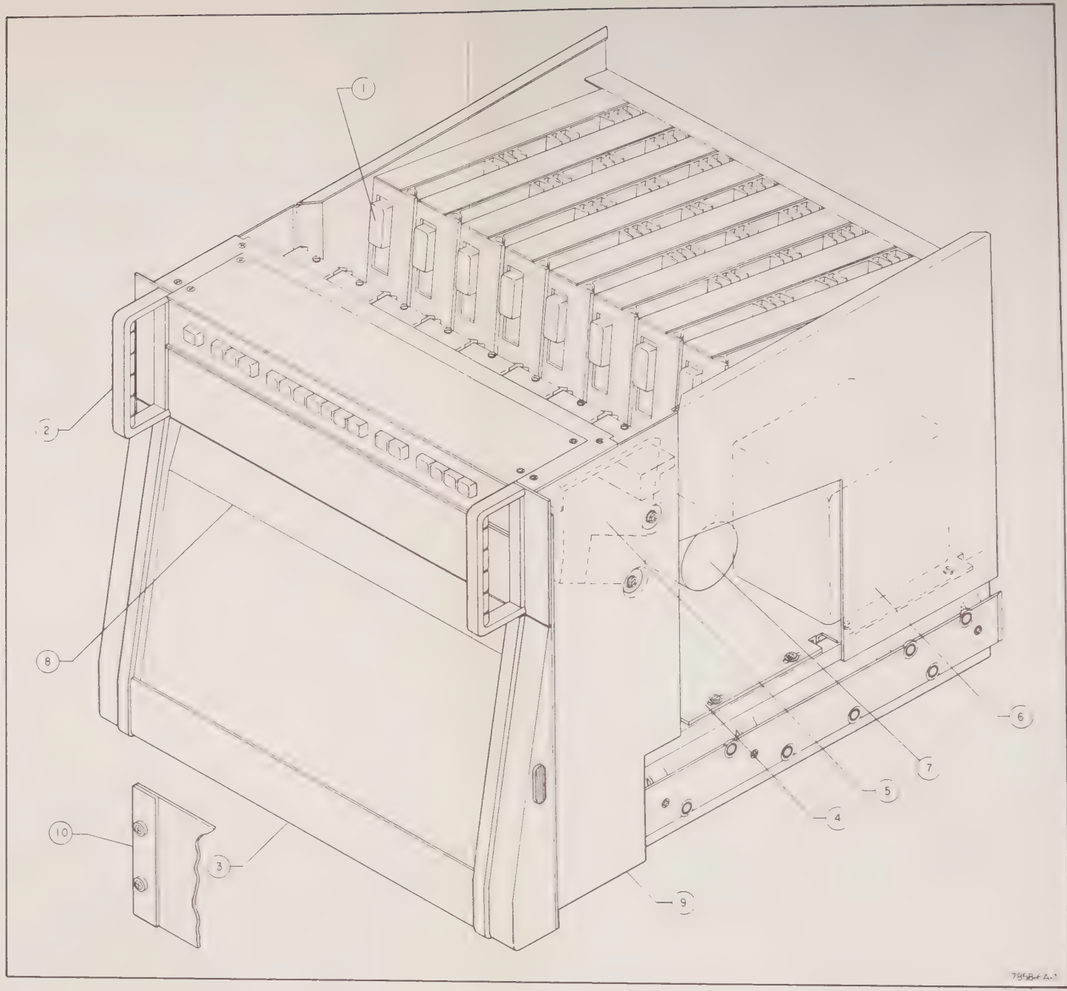


Figure 6A1 Oscillographic Ink Recorder, 7848A

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A2-	07850-62000	DRIVER AMPLIFIER ASSEMBLY (see Figure 6A1-1 for NHA)	Ref.	
-1	07850-02050	. COVER		
		(ATTACHING PARTS)		
-2	2200-0105	. SCREW, Machine	2	
		---*---		
-3	07850-62010	. BOARD ASSEMBLY, P.C. (see Figure 6A3-3 for breakdown).	1	
		(ATTACHING PARTS)		
-4	2200-0103	. SCREW, Machine	5	
		---*---		
-5	201598-1	. CONNECTOR, Receptacle (02660)	1	
		(ATTACHING PARTS)		
-6	201675-1	. CATCH, Locking Spring (02660)	2	
-7	1251-1006	. GUIDE PIN	1	
-8	1251-1005	. GUIDE SOCKET	1	
-9	2190-0071	. WASHER, Lock No. 4	2	
-10	2260-0011	. NUT, Hex No. 4	2	
		---*---		
-11	07850-02040	. BRACKET, Connector	1	
		(ATTACHING PARTS)		
-12	2200-0105	. SCREW, Machine 5/16	2	
		---*---		
-13	80D-832-77C	. SCREW	1	
-14	07850-22070	. RETAINER, Screw	1	
-15	07850-62030	. CHASSIS ASSEMBLY	1	
-16	1200-0168	. . SOCKET, Transistor	1	
		(ATTACHING PARTS)		
-17	0361-0346	. . RIVET	2	
		---*---		
-18	133-32-10-024	. . SOCKET, Transistor (71785).	1	
		(ATTACHING PARTS)		
-19	0361-0362	. . RIVET	2	
		---*---		
-20	0380-0758	. . STAND-OFF	3	
-21	0380-0759	. . STAND-OFF	2	
-22	1480-0022	. . PIN	1	
-23	1850-0409	. . TRANSISTOR, 2N2664	1	
		(ATTACHING PARTS)		
-24	2740-0003	. . NUT, Kemp No. 10	1	
-25	1200-0080	. . WASHER, Flat	2	
		---*---		

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A2-26	1854-0072	. . TRANSISTOR, 2N3054.	1	
		(ATTACHING PARTS)		
-27	86D-832-8F	. . SCREW, Machine 8-32 x 1/2	4	
		---*---		
-28	0340-0417	. . WASHER, Thermalloy.	1	
-29	2N2869/2N301	. . TRANSISTOR, 2N2869/2N301 (18724).	1	
-30	0340-0416	. . WASHER, Thermalloy.	1	
	07850-02030	. . CHASSIS, Stenciled	1	

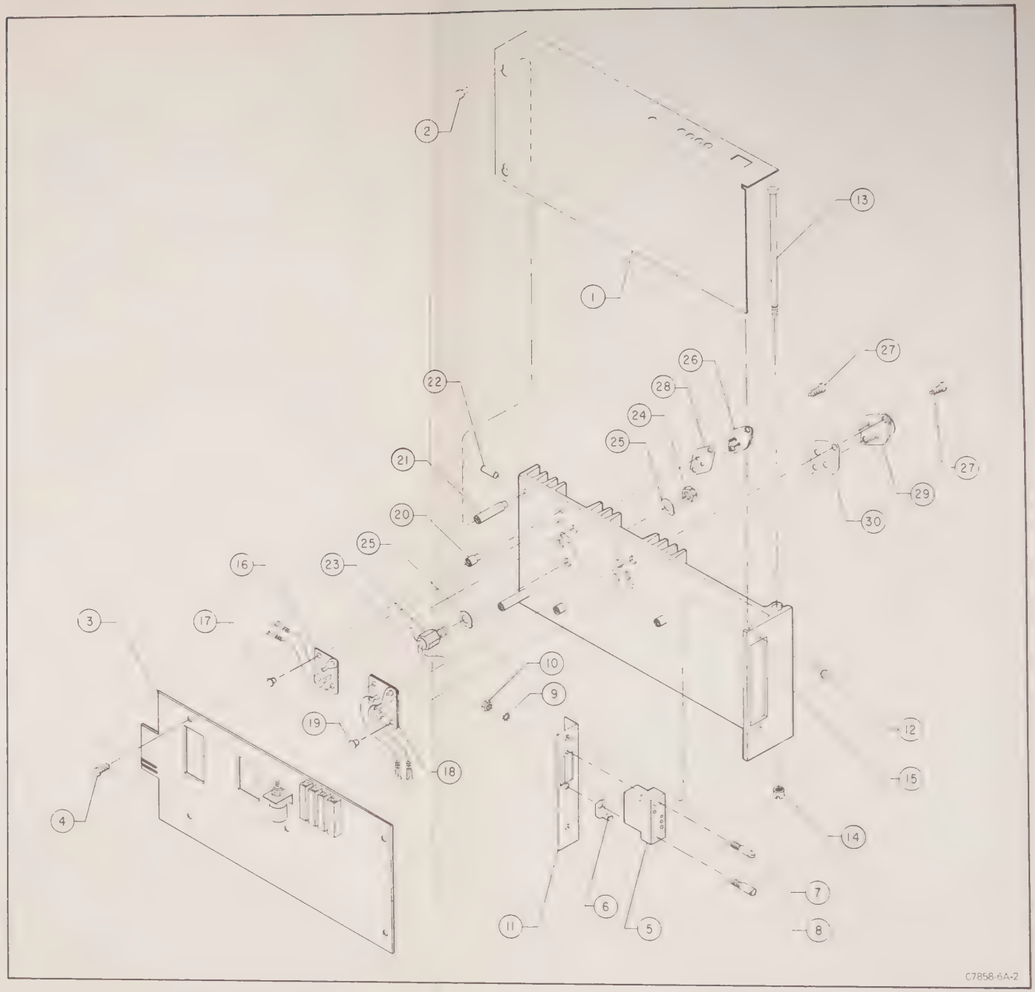


Figure 6A2 Driver Amplifier Assembly, 07850-62000

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A3-	07850-62010	BOARD ASSEMBLY, P.C. (see Figure 6A2-3 for NHA)	Ref.	
-1	29C214A3	. CAPACITOR, Fxd, ceramic 0.01μF 20% 1000 Vdc (56289)	2	
-2	RDM15F751J3S	. CAPACITOR, Fxd, mica 750PF 5% 300 V (14655)	1	
-3	WMF4W1E	. CAPACITOR, Fxd, mica 3900PF 2% 500 Vdc (14655)	1	
-4	D6-201	. CAPACITOR, Fxd, ceramic 200PF 10% 600 Vdc (71590)	1	
-5	331-Z5U-101K	. CAPACITOR, Fxd, ceramic 100PF 10% 500 Vdc (15450)	1	
-6	WMF2S22	. CAPACITOR, Fxd, mylar .022μF 10% 200 Vdc (14655)	2	
-7	WMT1P1	. CAPACITOR, Fxd, mylar 1μF 100 Vdc 10% (14655)	2	
-8	VE1A334K	. CAPACITOR, Fxd, metalized paper .33μF 10% 100 Vdc (12406) . .	1	
-9	192P47392-PTS	. CAPACITOR, Fxd, mylar .047μF 10% 200 Vdc (56289)	1	
-10	30D506G015CB 2-DSM	. CAPACITOR, Fxd, elect 50μF, 15 Vdc +75 -10% (56289)	1	
-11	7-85PSD50-25NPS	. CAPACITOR, Fxd, elect 50μF, 25 Vdc +50 -20% (05844)	2	
-12	3-85ASD1-10NP	. CAPACITOR, Fxd, elect 1μF 10% 10 Vdc (05844)	1	
-13	0686-1005	. RESISTOR, 10 OHM 5%	2	
-14	0686-1015	. RESISTOR, 100 OHM 5%	1	
-15	0686-1025	. RESISTOR, 1K 5%	2	
-16	0686-1035	. RESISTOR, 10K 5%	3	
-17	0686-1535	. RESISTOR, 15K 5%	3	
-18	0686-2215	. RESISTOR, 220 OHM 5%	1	
-19	0686-2225	. RESISTOR, 2.2K 5%	1	
-20	0686-2235	. RESISTOR, 22K 5%	1	
-21	0686-2245	. RESISTOR, 220K 5%	1	
-22	0686-2725	. RESISTOR, 2.7K 5%	1	
-23	0686-4725	. RESISTOR, 4.7K 5%	2	
-24	0698-3348	. RESISTOR, 4640 1%	2	
-25	0698-3349	. RESISTOR, Fxd, film 5760 OHM 1%	1	
-26	0698-4881	. RESISTOR, Fxd, film 953 OHMS, 1%	1	
-27	0698-5895	. RESISTOR, 50K 1%	2	
-28	0698-5914	. RESISTOR, 12.5K 1%	1	
-29	0698-5929	. RESISTOR, 2.5K 1%	1	
-30	0698-5952	. RESISTOR, 4K 1%	1	
-31	0698-5963	. RESISTOR, 4.7K 1%	1	
-32	0698-5966	. RESISTOR, 5K 1%	4	
-33	0698-5982	. RESISTOR, Fxd, film 8.2K 1%	1	
-34	CEC T-0	. RESISTOR, Fxd, film 6190 OHMS 1% 1/2W (75042)	2	
-35	CEC T-0	. RESISTOR, Fxd, film 20K 1% 1/2W (75042)	1	
-36	CEC T-0	. RESISTOR, Fxd, film 1.5K 1% 1/2W (75042)	2	
-37	MF7C T-0	. RESISTOR, Fxd, film 150 OHMS 1% 1/2W (75042)	1	

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A3-38	0757-0817	. RESISTOR, 750 OHM 1%	2	
-39	MF7C T-0	. RESISTOR, Fxd, film 2K 1% 1/2W (75042)	2	
-40	MF7C T-0	. RESISTOR, Fxd, film 6810 OHMS 1% 1/2W (75042)	1	
-41	MF7C T-0	. RESISTOR, Fxd, film 7.5K 1% 1/2W (75042)	1	
-42	MF7C T-0	. RESISTOR, Fxd, film 10K 1% 1/2W (75042)	6	
-43	MF7C T-0	. RESISTOR, Fxd, film 15K 1% 1/2W (75042)	2	
-44	242E	. RESISTOR, Fxd, WW 2 OHM 3W 5% (75042)	1	
-45	0811-2331	. RESISTOR, 500 OHM 5W	1	
-46	0837-0037	. RESISTOR, Thermal, 310 OHMS	1	
-47	119437B	. TEST POINT, Red (78947)	2	
-48	2N2869/2N301	. TRANSISTOR, PNP Power (see Figure 6A2-29) (02735)	Ref.	
-49	1850-0409	. TRANSISTOR, 2N2664 (see Figure 6A2-23)	Ref.	
-50	SS2111	. TRANSISTOR, 53-09, PNP Silicon (04713)	2	
-51	1853-0020	. TRANSISTOR, SM9143	4	
-52	2N708	. TRANSISTOR, NPN Silicon (02735)	2	
-53	1854-0072	. TRANSISTOR, 2N3054 (see Figure 6A2-26)	Ref.	
-54	2N3393	. TRANSISTOR, 2N3393 NPN Silicon (03508)	8	
-55	SG3396	. SEMICONDUCTOR DEVICE, Diode (03877)	2	
-56	1N485B	. SEMICONDUCTOR DEVICE, Diode (93332)	1	
-57	CD35529	. SEMICONDUCTOR DEVICE, Diode, Zener 2.4 V 5% (07910)	1	
-58	G100K066	. SEMICONDUCTOR DEVICE, Diode (15281)	2	
-59	2100-2288	. RESISTOR, Variable, 50K	1	
-60	2100-2319	. RESISTOR, Variable, 20K	1	
-61	2100-2321	. RESISTOR, Variable, 1K	2	
-62	5080-7310	. TRANSISTOR, 2N3393 Matched Pair	1	
-63	5080-7376	. SEMICONDUCTOR DEVICE, Diode, Matched Pair	1	
-64	9100-2090	. CHOKE, Variable	1	
-65	07850-02060	. BRACKET	1	
-66	752-458	. BOARD, P.C.	1	

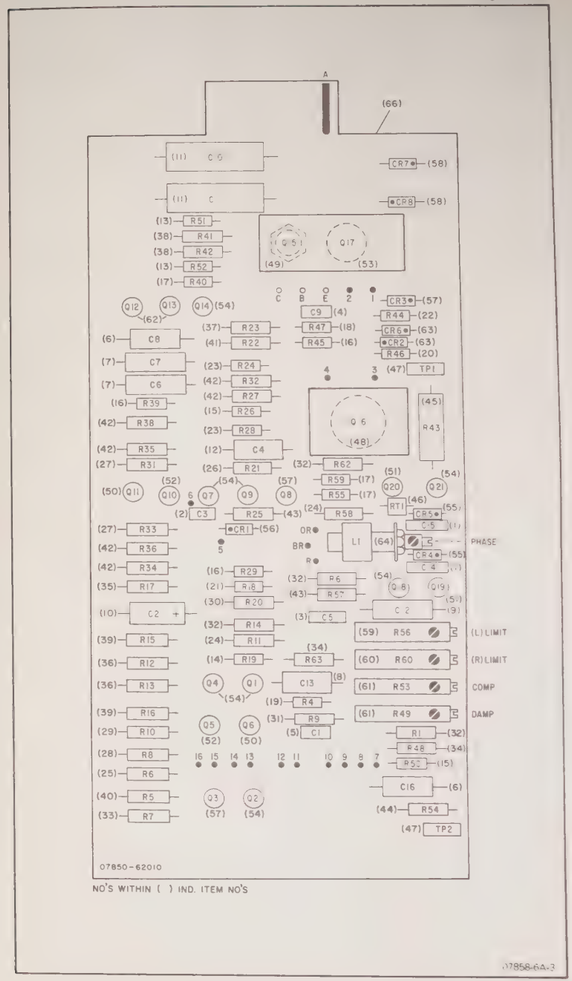


Figure 6A3 Board Assembly, p.c., 07850-62010

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A4-	07850-63000	CONTROL PANEL ASSEMBLY (see Figure 6A1-2 for NHA)	Ref.	
-1	07850-03120	. FRAME, Cover	1	
		(ATTACHING PARTS)		
-2	2360-0183	. SCREW, Machine 6-32 x 3/8	12	
		---*---		
-3	07850-03070	. PANEL, Ornamental	1	
		(ATTACHING PARTS)		
-4	0590-0052	. NUT, Saddle	8	
		---*---		
-5	07850-03030	. PANEL, Overlay	1	
-6	00780-60210	. LAMP & LENS ASSEMBLY	1	
-7	0370-0162	. KNOB.	17	
-8	5000-0343	. LABEL, Switch (Power).	1	
-9	5000-0335	. LABEL, Switch (Off).	2	
-10	5000-0336	. LABEL, Switch (Run)	1	
-11	5000-0333	. LABEL, Switch (Remote)	1	
-12	5000-3210	. LABEL, Switch (.025).	1	
-13	5000-3209	. LABEL, Switch (.05)	1	
-14	5000-3211	. LABEL, Switch (.10)	1	
-15	5000-3208	. LABEL, Switch (.25)	1	
-16	5000-3207	. LABEL, Switch (.50)	1	
-17	5000-3206	. LABEL, Switch (1.0)	1	
-18	5000-3205	. LABEL, Switch (2.0)	1	
-19	5000-3204	. LABEL, Switch (X1).	1	
-20	5000-3203	. LABEL, Switch (X 100)	1	
-21	5000-3202	. LABEL, Switch (Sec.).	1	
-22	5000-3201	. LABEL, Switch (Min.)	1	
-23	5000-3200	. LABEL, Switch (Event)	1	
-24	7120-1254	. TRADE MARK (hp).	1	
-25	07850-03130	. BRACKET, Lamp	1	
		(ATTACHING PARTS)		
-26	2420-0006	. NUT, Hex Kep 40T-6.	6	
		---*---		
-27	L40/W	. LAMP, Lumiline (24455)	1	
-28	5674-3	. CAP, End (Lamp) (24455)	2	
-29	5670-3	. SOCKET, Lamp (24455)	2	
		(ATTACHING PARTS)		
-30	2200-0068	. SCREW, Machine, bh	4	
	2190-0071	. WASHER, Lock 72A-4	4	

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A4-	0590-0415	. NUT, Pem 4-40	4	
		---*---		
-31	07850-63140	. TERMINAL BOARD ASSEMBLY	1	
		(ATTACHING PARTS)		
-32	2200-0103	. SCREW, Machine 4-40 x 1 4 SEMS	4	
		---*---		
-33	DELETED			
-34	242E	. . RESISTOR, Fxd, WW 390 ohm 5% 3W (56289)	1	
	07850-03140	. . BOARD, Etched	1	
-35	07850-63141	. TERMINAL BOARD ASSEMBLY	1	
	07850-03140	. . BOARD, Terminal		
-36	07850-63010	. CABLE ASSEMBLY, Control Panel	1	
-37	201357-1	. . CONNECTOR, Block (02660)	1	
	1251-1005	. . SOCKET, Guide	1	
	1251-1006	. . GUIDE PIN	1	
	66098-1	. . CONTACT PIN (02660)	2	
	201496-1	. . SPRING, Locking (02660)	2	
	201224-1	. . CLAMP, Strain Relief (02660)	1	
	1251-1679	. . CONTACT PIN	25	
-38	07850-03081	. HINGE PANEL, Right	1	
-39	07850-03082	. HINGE PANEL, Left	1	
-40	07850-63030	. SPEED SWITCH ASSEMBLY	1	
		(ATTACHING PARTS)		
-41	2360-0115	. SCREW, Machine 6-32 x 5/16 SEMS	5	
		---*---		
	41C169A	. . CAPACITOR, Fxd, ceramic .05 μF, 20% 1000V (56289)	4	
	3101-1027	. . SWITCH, Speed Change	1	
-42	3101-1028	. SWITCH, Marker	1	
-43	3101-1140	. SWITCH, Base	1	
-44	07850-43010	. KNOB, Switch	1	
-45	07850-23020	. HANDLE	2	
-46	5040-0705	. TRIM, Plastic (L.H.)	2	
-47	5040-0706	. TRIM, Plastic (R.H.)	2	
-48	07850-23060	. TRIM, Panel	2	
-49	07850-03010	. PANEL	1	

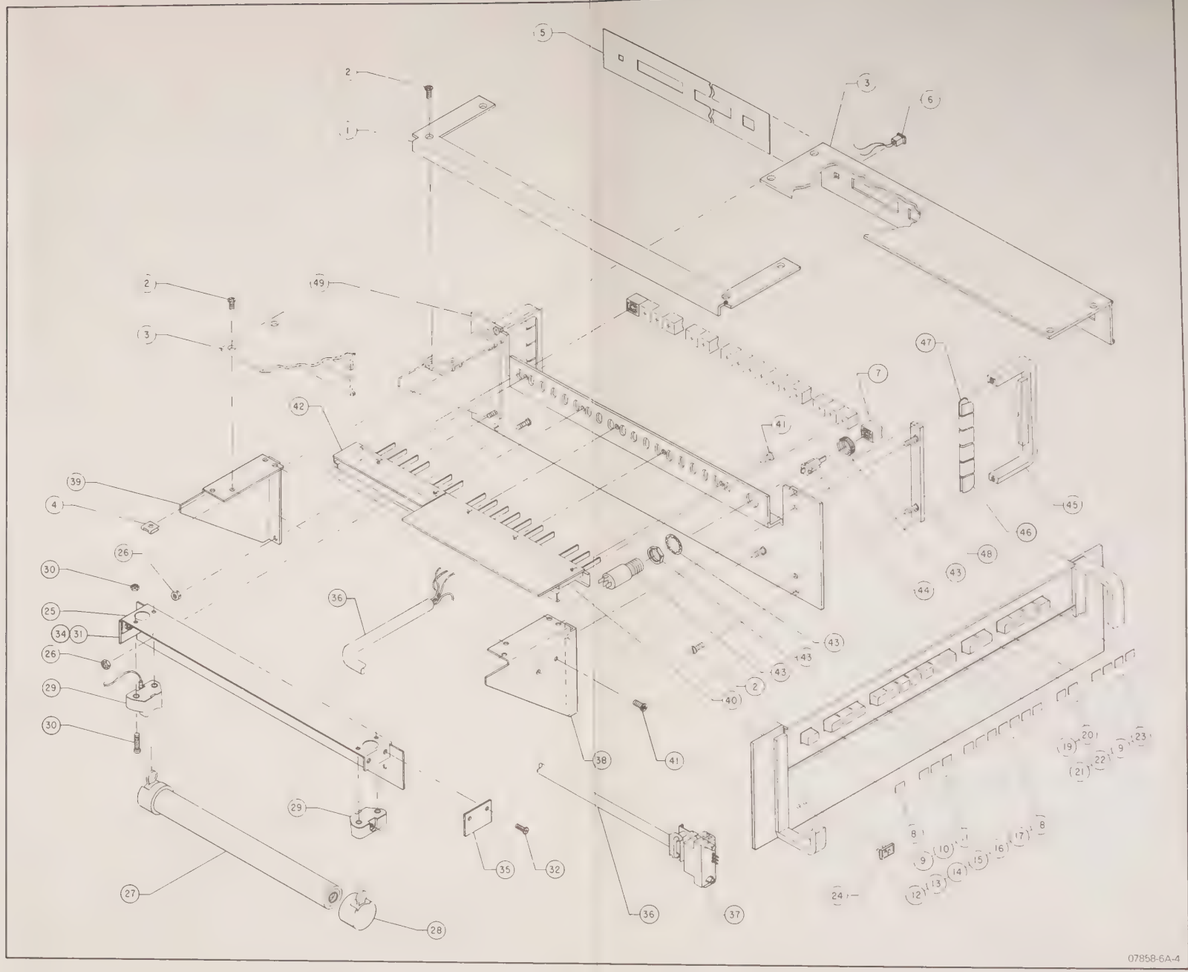


Figure 6A4 Control Panel Assembly, 07850-63000

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
9A5-	07858-61020	DOOR ASSEMBLY, Front (see Figure 6A1-3 for NHA)	Ref.	
-1	07858-21220	. TRIM, Door (R. H.)	1	
-2	07858-21230	. TRIM, Door (L. H.)	1	
		(ATTACHING PARTS)		
-3	2360-0117	. SCREW, Machine 6-32 x 3/8 SEMS	8	
-3A	2190-0757	. WASHER, Flat No. 6-32	2	
		---*---		
-4	07858-01770	. STRIP, Retainer	2	
-5	07858-01110	. PANEL, Door Overlay	1	
		(ATTACHING PARTS)		
-6	2420-0006	. NUT, Keps No. 6-32	4	
		---*---		
-7	07858-01100	. SUPPORT, Window	1	
-8	07858-01120	. WINDOW, Door	1	
-9		. HINGE and PIN ASSEMBLY	1	
	07858-21200	. . HINGE, Door	1	
	1480-0037	. . PIN, Dowel, long	1	
-9A		. HINGE and PIN ASSEMBLY	1	
	07858-21200	. . HINGE, Door	1	
	1480-0022	. . PIN, Dowel, short	1	
		(ATTACHING PARTS for 9 & 9A)		
-10	2200-0107	. SCREW, Machine 4-40 x 3/8 SEMS	4	
		---*---		
-11	07858-21210	. BLOCK, Door Lock	2	
		(ATTACHING PARTS)		
-12	2510-0051	. SCREW, Machine, 8-32 x 5/8 SEMS	2	
		---*---		
-13	07858-21170	. PLATE, Lock Block	1	
-14	07858-21180	. PIN, Lock	1	
-15	1460-0817	. SPRING	2	
-16	07858-41060	. KNOB, Push	1	
-17	07858-21150	. DOOR, Front (casting)	1	

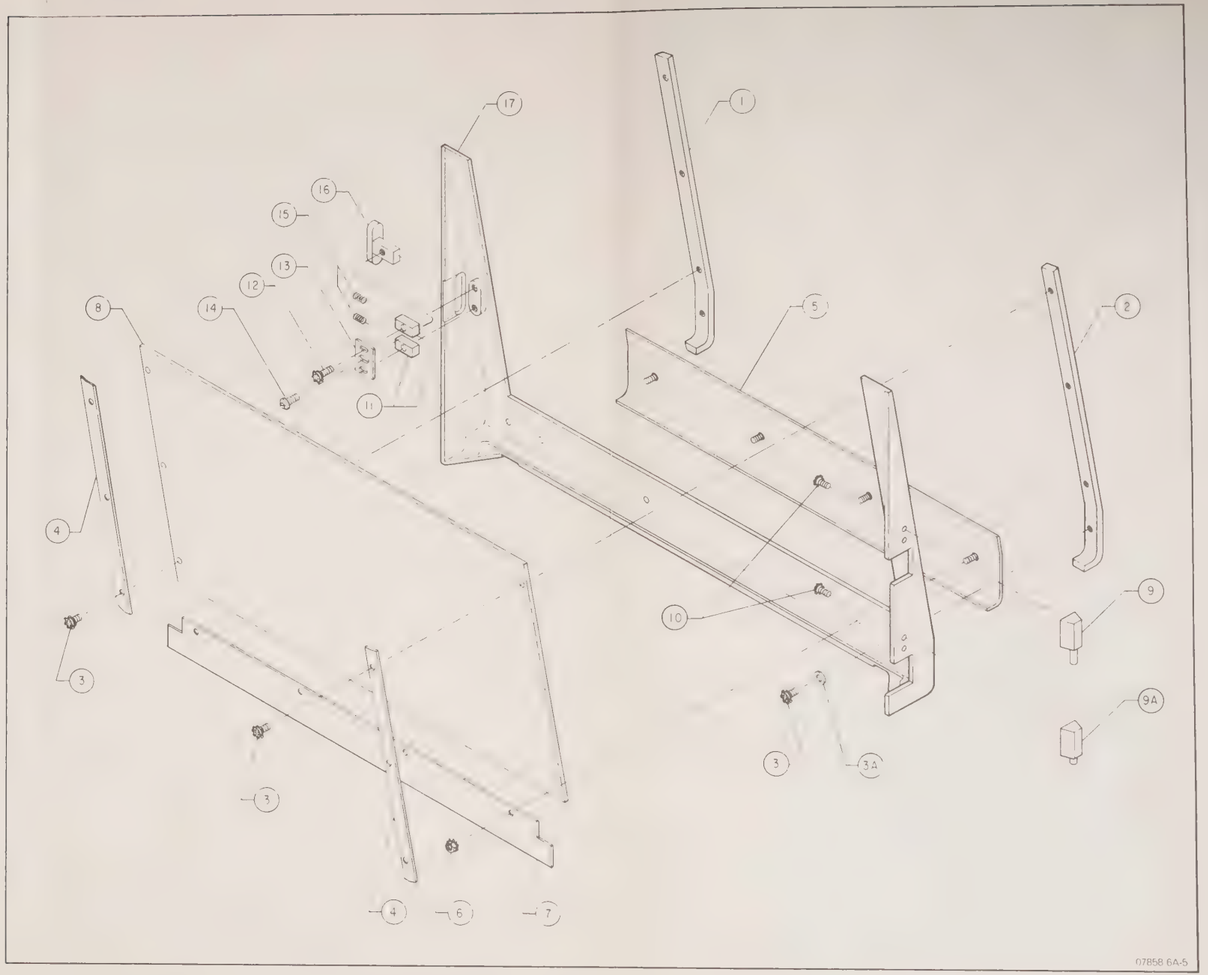


Figure 6A5 Door Assembly, Front, 07858-61020

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A6-	07858-67000	MOTOR & SPEED CHANGE W/AIR REGULATOR (see Figure 6A1-4 for NHA)	Ref.	
-1	07858-67120	. AIR REGULATION ASSEMBLY (see Figure 6A7 for breakdown) . . . (ATTACHING PARTS)	1	
-2	2510-0041	. SCREW, Machine 8-32 x 1/4 SEMS	2	
-3	2190-0055	. WASHER, Flat 8-32.	2	
-4	2360-0115	. SCREW, Machine 6-32 x 5/16 SEMS	2	
-5	2190-0757	. WASHER, Flat 6-32. . . . . ---*---	4	
-6	150XL037	. BELT, Timing (90179).	1	
-7	07858-27100	. ECCENTRIC, Motor Drive . . . . . (ATTACHING PARTS)	1	
-8	0570-0157	. SETSCREW. . . . . ---*---	1	
-9	1500-0097	. PULLEY, 12 Grooves . . . . . (ATTACHING PARTS)	1	
-10	0570-0173	. SETSCREW. . . . . ---*---	2	
-11	SKPL330BOT	. MOTOR, 1800RPM, 60Hz (93369). . . . . (ATTACHING PARTS)	1	
-12	80D-1/420-6V	. SCREW, Machine, hex hd 1/4-20 x 3/8 . . . . . ---*---	2	
-13	200P1904-OCT	. CAPACITOR, Fxd, paper 5μF, 10% 370 Vac (56289) . . . . . (ATTACHING PARTS)	1	
-14	0160-2729	. BRACKET, Mounting	2	
-15	0590-0439	. NUT, Stop 10-32 . . . . . ---*---	2	
-16	301-66	. HOOD, Capacitor (56289).	1	
-17	07858-07030	. BRACKET, Motor . . . . . (ATTACHING PARTS)	1	
-18	2680-0055	. SCREW, Machine 10-32 x 1/2 SEMS	4	
-19	3050-0019	. WASHER, Flat 10-32 . . . . . ---*---	2	
-20	07858-47120	. GUARD, Term. & Chain . . . . . (ATTACHING PARTS)	1	
-21	2360-0117	. SCREW, Machine 6-32 x 3/8 SEMS . . . . . ---*---	4	
-22	07858-67100	. GEAR TRAIN ASSEMBLY (see Figure 6A8 for breakdown). . . . . (ATTACHING PARTS)	1	
-23	2510-0049	. SCREW, Machine 8-32 x 1/2 SEMS . . . . . ---*---	4	

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A6-24	07858-07020	. GASKET, Gear Box	1	
-25	07858-07230	. BOARD, Terminal	1	
		(ATTACHING PARTS)		
-26	2510-0053	. SCREW, Machine 8-32 x 1/2 SEMS	2	
-26A	0590-0100	. NUT, "T"	2	
		---*---		
-27	MDL-1/2	. FUSE, S-B 0.5A (71400)	2	
	31303.2	. FUSE, S-B 3.2A (75915)	1	
	313005	. FUSE, S-B 5A (75915)	1	
	MDL-8	. FUSE, S-B 8A (71400)	2	
-28	HK P-L	. FUSEHOLDER (71400)	6	
-29	07858-27080	. SUPPORT, Terminal Board		
	07858-67080	. CABLE	1	
-30	07858-67020	. CABLE ASSEMBLY	1	
-31	201359-1	. . CONNECTOR, Plug (02660)	2	
-32	1251-1005	. . GUIDE, Socket	1	
-33	1251-1006	. . GUIDE, Pin	1	
-34	201674-1	. . SPRING, Locking (pair) (02660)	1	
-35	1251-1698	. . CLAMP (w/hardware)	1	
-36	1200-0764	. CONNECTOR, 7 Pin	1	
		(ATTACHING PARTS)		
-37	0361-0350	. RIVET, Tubular	2	
		---*---		
-38	701-8T6-64	. SPACER	2	
		(ATTACHING PARTS)		
-39	2360-0121	. SCREW, Machine 6-32 x 1/2 SEMS	2	
		---*---		
-40	07858-07010	. CHASSIS, Gear Box	1	

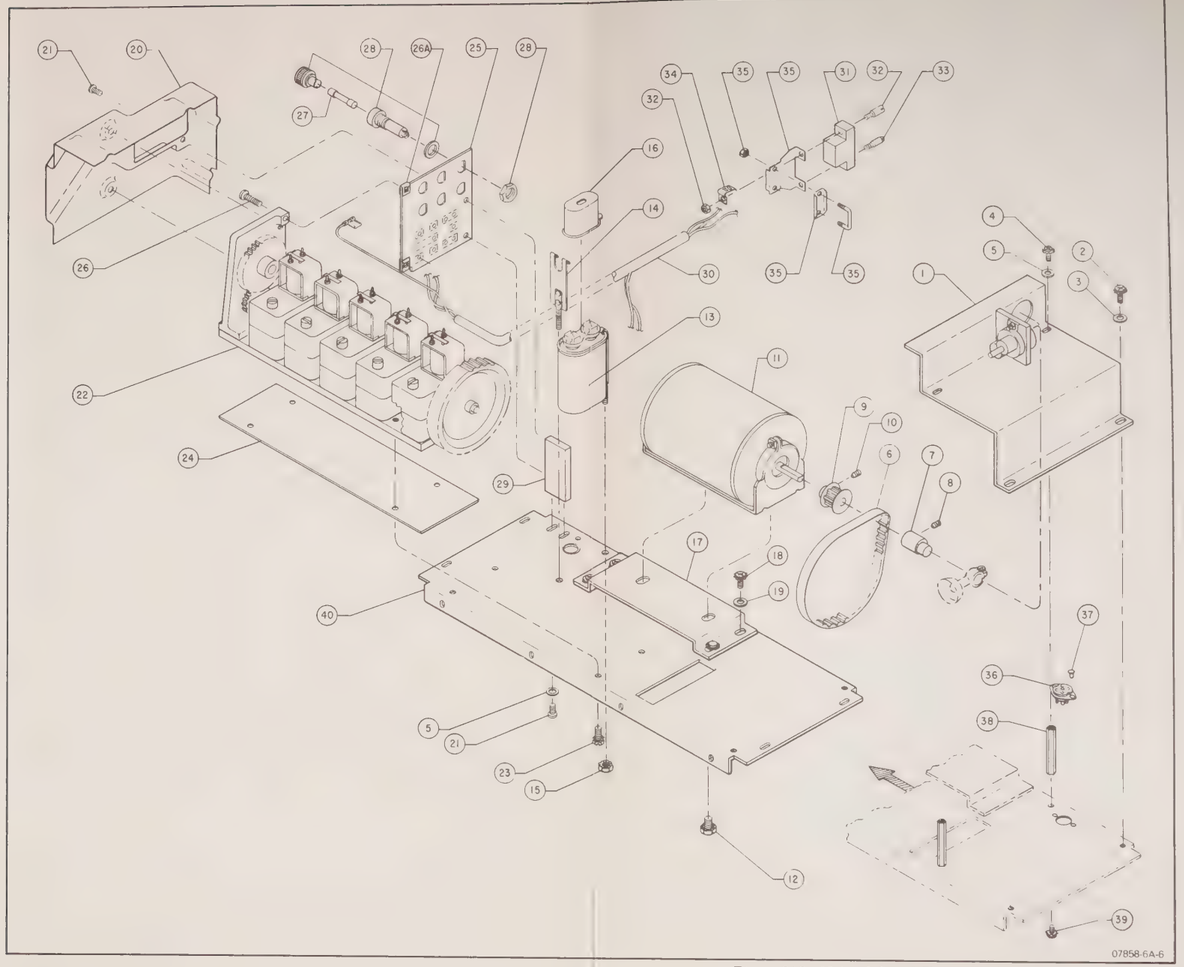


Figure 6A6 Motor & Speed Change W/Air Regulator, 07858-67000

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A7-	07858-67120	AIR REGULATION ASSEMBLY (see Figure 6A6-1 for NHA)	Ref.	
-1	0101-0085	. VALVE, Solenoid	2	
-2	0101-0114	. VALVE, Solenoid	1	
		(ATTACHING PARTS)		
-3	2510-0043	. SCREW, 8-32 x 5/16	6	
		---*---		
-4	07858-27110	. FITTING, Hose	14	
-5	9301-0165	. "Y" CONNECTOR	1	
-6	0890-0832	. TUBING, Tygon	AR	
-7	EB-954	. REGULATOR, Pressure (07282)	3	
-8	9301-0164	. "T" CONNECTOR	3	
-9	07858-27360	. FITTING, Partition	3	
		(ATTACHING PARTS)		
-10	2950-0098	. NUT, Hex.	3	
		---*---		
-11	3162-0007	. PUMP, Air	1	
		(ATTACHING PARTS)		
-12	2200-0111	. SCREW, 4-40 x 1/2	2	
-12A	0590-0199	. NUT, Hex, No. 4-40	2	
		---*---		
-13	07858-27340	. BRACKET, Mounting, pump	1	
		(ATTACHING PARTS)		
-14	2200-0105	. SCREW, 4-40 x 5/16 SEMS	3	
-14A	3050-0269	. WASHER, Flat No. 4-40	3	
		---*---		
	07858-27370	. ORIFICE	2	
-15	1251-1835	. CONNECTOR, Plug (95354)	1	
-16	07858-07040	. BRACKET, Motor Partition	1	

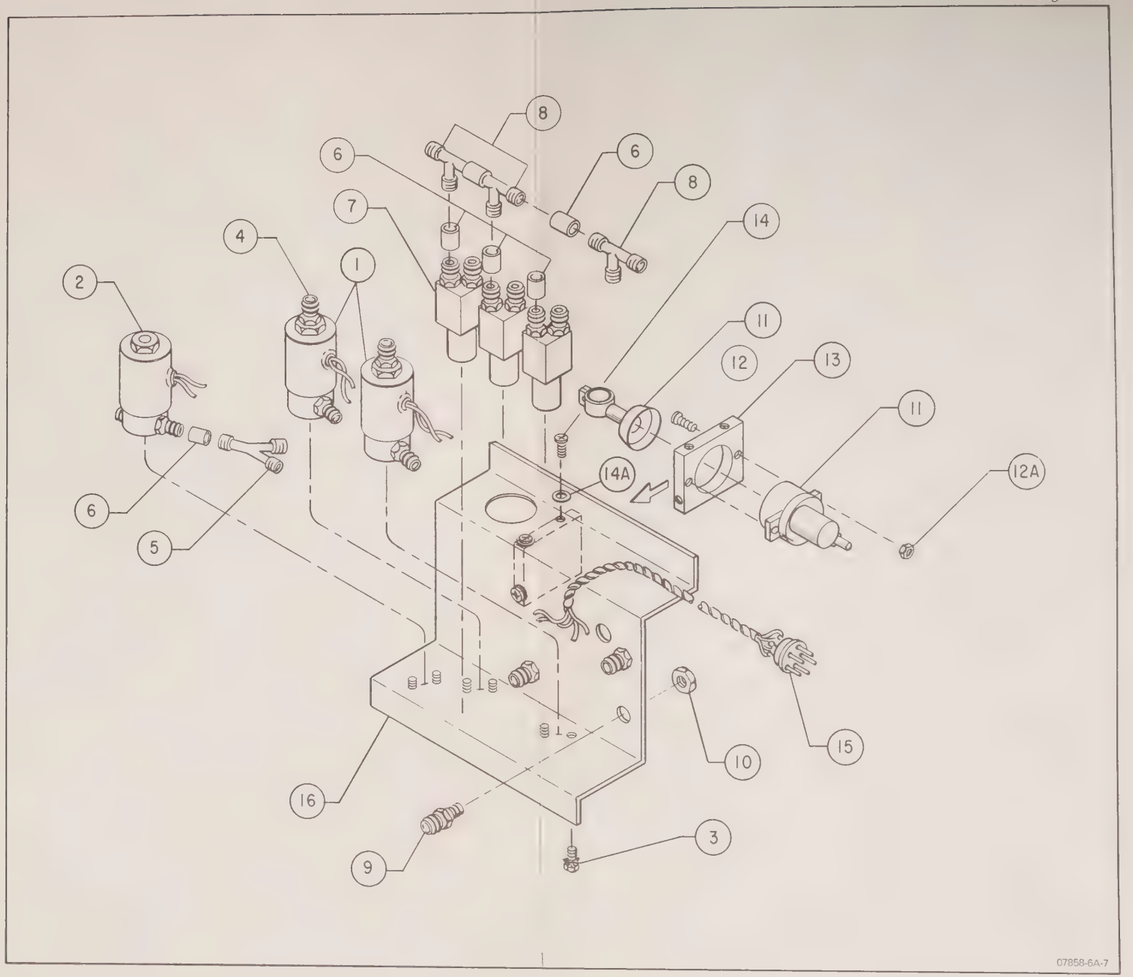


Figure 6A7 Air Regulator Assembly, 07858-67120

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A8-	07858-67100	GEAR TRAIN ASSEMBLY (see Figure 6A6-16 for NHA)	Ref.	
-1	1500-0098	. PULLEY.	1	
		(ATTACHING PARTS)		
-2	0510-1014	. RING, Retaining.	2	
		---*---		
-3	1500-0764	. COUPLING	6	
-4	0758-67030	. IDLER ASSEMBLY, Gear.	1	
		(ATTACHING PARTS)		
-5	2510-0045	. SCREW, Machine, 8-32	12	
		---*---		
-6	1430-0460	. . SPROCKET, 25T, 3/16P	1	
		(ATTACHING PARTS)		
-7	81A-832A	. . SETSCREW.	2	
-8	0510-1011	. . KEY, Woodruff	2	
		---*---		
-9	2190-0833	. . SHIM	2	
-10	1410-0170	. . BEARING, Flanged	2	
-11	5020-4398	. . GEAR, 102T, 48P	1	
-12	825-50	. . SHAFT, 3/8 in.	1	
-13	5020-4399	. . GEAR, 61T.	1	
		(ATTACHING PARTS)		
-14	0510-1011	. . RING, Retaining	1	
		---*---		
-15	825-51	. . SHAFT, 1/4 in.	1	
	07858-27070	. . HOUSING, Idler Gear	1	
-16	0758-47111	. GEAR BOX, Top	5	
		(ATTACHING PARTS)		
-16A	830-832-3	. THUMBSCREW	10	
		---*---		
-17	5020-4394	. GEAR, 34T	1	
-18	1410-0807	. BEARING	1	
-19	1410-0820	. BEARING	10	
-20	01250-21104	. SPACER.	5	
-21	No Number	. GEAR TRAIN ASSEMBLY.	1	
-22	5020-4386	. GEAR, 80 Teeth.	3	
		(ATTACHING PARTS)		
-23	0510-1051	. KEY, Woodruff	12	
		---*---		
-24	07858-67111	. GEAR TRAIN ASSEMBLY.	5	
-25	1530-1099	. CLUTCH, Sleeve	5	

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A8-26	11-82931	. SPRING, Clutch (38480)	5	
-27	07858-67115	. GEAR TRAIN ASSEMBLY	5	
-28	07858-67112	. SHAFT & HUB ASSEMBLY	1	
-29	No Number	. GEAR TRAIN ASSEMBLY	2	
-30	07858-67113	. SHAFT & HUB ASSEMBLY	3	
-31	No Number	. GEAR TRAIN ASSEMBLY	1	
-32	5020-4385	. GEAR, 64 Teeth	1	
-33	No Number	. GEAR TRAIN ASSEMBLY	1	
-34	5020-4384	. GEAR, 48 Teeth	1	
-35	07858-67114	. SHAFT & HUB ASSEMBLY	1	
-36	1410-0819	. BEARING	10	
-37	No Number	. GEAR TRAIN ASSEMBLY	3	
-38	07858-67116	. GEAR TRAIN ASSEMBLY	5	
-39	5020-4393	. GEAR, 16 Teeth	3	
-40	01250-21101	. SPACER	5	
-41	No Number	. GEAR TRAIN ASSEMBLY	1	
-42	5020-4388	. GEAR, 32 Teeth	1	
-43	0510-0060	. RING, Grip	2	
-44	825-48	. SHAFT	2	
-45	No Number	. GEAR TRAIN ASSEMBLY	1	
-46	5020-4389	. GEAR, 48 Teeth	1	
-47	0491-0034	. SOLENOID	5	
		(ATTACHING PARTS)		
-47A	2200-0105	. SCREW, Machine 4-40 x 5/16 SEMS	10	
-47B	3050-0269	. WASHER, Flat 4-40	10	
		---*---		
-48	07858-07280	. SPRING	5	
		(ATTACHING PARTS)		
-49	2510-0088	. SCREW, Pan hd 8-32	12	
-50	2190-0409	. WASHER, Lock	10	
		---*---		
-51	07858-27140	. INSERT	10	
-52	07858-47112	. GEAR BOX, Bottom	5	
-53	07858-27030	. PLATE, Gear Train	1	

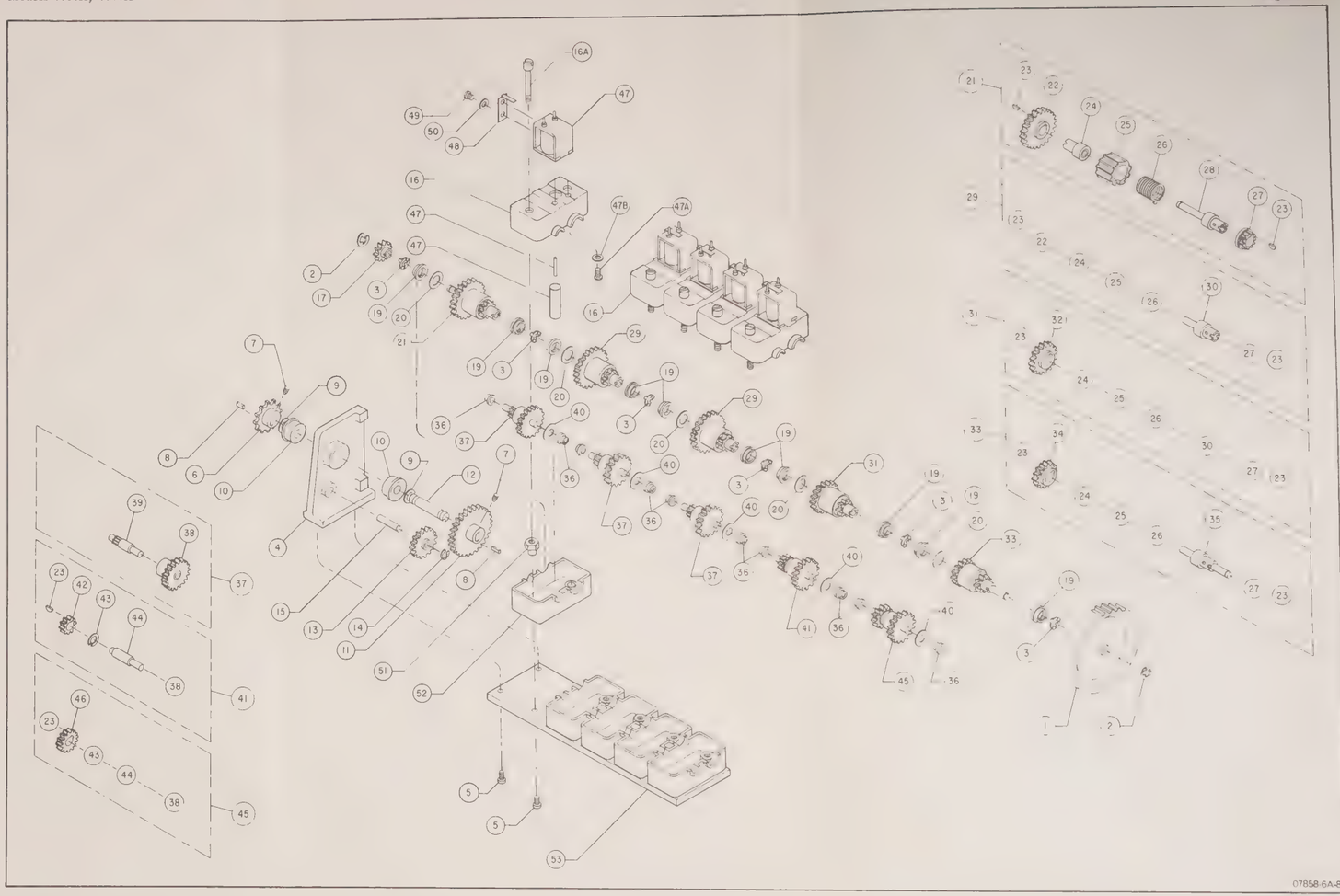


Figure 6A8 Gear Train Assembly, 07858-67100

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A9-	Reference	GALVANOMETER BANK ASSEMBLY (see Figure 6A1-5 for NHA)	Ref.	
-1	07858-01750	. COVER, Front Galvanometer	1	
		(ATTACHING PARTS)		
-2	2200-0101	. SCREW, Machine 4-40 x 3/16	4	
		---*---		
-3	07850-61002	. GALVANOMETER MODULE ASSEMBLY, L. H. Marker (see Figure 6A12 for breakdown)	1	
-4	07850-61001	. GALVANOMETER MODULE ASSEMBLY, R. H. Marker (see Figure 6A12 for breakdown)	1	
-5	07850-61000	. GALVANOMETER ASSEMBLY (see Figure 6A10 for breakdown)		
		(ATTACHING PARTS)		
-6	3030-0039	. SCREW, Machine, Soc hd, 10-32 x 5/8	16	
		---*---		
-7	07858-61140	. MANIFOLD SHUT-OFF ASSEMBLY	1	
		(ATTACHING PARTS)		
-7A	2200-0103	. SCREW, Machine 4-40 x 1/4 SEMS	8	
		---*---		
-8	07858-21120	. SUPPORT, Galvanometer Module	2	
		(ATTACHING PARTS)		
-9	2680-0055	. SCREW, Machine 10-32 x 1/2 SEMS	9	
		---*---		
-10	07858-21160	. PIN, Eccentric	2	
		(ATTACHING PARTS)		
-11		. NUT, Hex 10-32 Keps	2	
		---*---		
-12	07858-21450	. BAR, Allignment	1	
		(ATTACHING PARTS)		
-13	3030-0303	. SETSCREW, Nylock	8	
		---*---		
-14	07858-21130	. CASTING, Galvanometer	1	
-15	07858-01760	. STRIP, Cover Mounting	4	
		(ATTACHING PARTS)		
-16	0520-0174	. SCREW, Machine 2-56 x 1/4 SEMS	8	
		---*---		

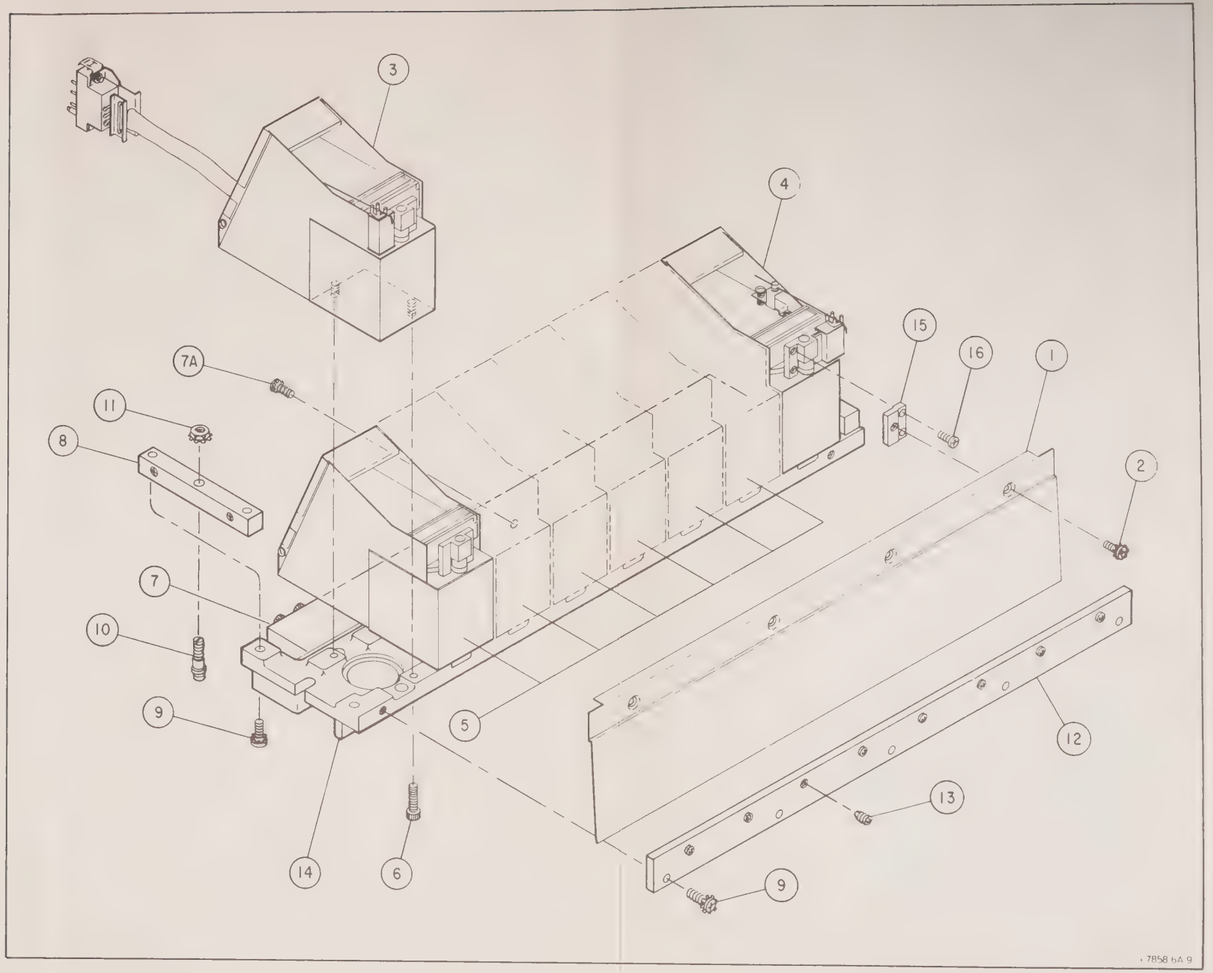


Figure 6A9 Galvanometer Bank Assembly, Reference

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A10-	07850-61000	GALVANOMETER MODULE ASSEMBLY (see Figure 6A9-5 for NHA) . . .	Ref.	
-1	07850-01070	. COVER, Rear	1	
		(ATTACHING PARTS)		
-2	2200-0137	. SCREW, Machine 4-40 x 3/16	7	
		---*---		
-3	07850-01191	. PLATE, Side R. H.	1	
		(ATTACHING PARTS)		
-4	2200-0137	. SCREW, Machine 4-40 x 3/16	Ref.	
-5	2200-0137	. SCREW, Machine	Ref.	
		---*---		
-6	708-8T4-91	. SPACER	1	
-7	07850-01192	. PLATE, Side L. H.	1	
-8	44-100-P20, 0.7A	. CIRCUIT BREAKER (06402).	1	
		(ATTACHING PARTS)		
-9	0520-0136	. SCREW, Machine 2-56 x 5/8	2	
-10	2190-0063	. WASHER, Lock No. 2	2	
-11	0610-0002	. NUT, Hex 2-56	2	
		---*---		
-12	1400-0381	. CLAMP, Cable	1	
		(ATTACHING PARTS)		
-13	2200-0143	. SCREW, Machine 4-40 x 3/8	1	
	2190-0746	. WASHER, Flat No. 4	1	
	2260-0011	. NUT, Hex 4-40	1	
		---*---		
-14	07850-61300	. STYLUS ASSEMBLY	1	
		(ATTACHING PARTS)		
-15	07850-01120	. CLIP, Retainer	1	
		---*---		
-16	07850-61110	. PINCH VALVE ASSEMBLY	1	
		(ATTACHING PARTS)		
-17	2200-0147	. SCREW, Machine 4-40 x 1/2	2	
	0520-0173	. SCREW, Machine 2-56 x 3/16	2	
		---*---		
-18	07850-0/030	. SHIELD ASSEMBLY.	1	
-19	07850-61100	. PREAMPLIFIER P. C. ASSEMBLY (see Figure 6A11 for breakdown). .	1	
		(ATTACHING PARTS)		
-20	0520-0133	. SCREW, Machine 2-56 x 1/2	2	
		---*---		
-21	07850-61130	. CABLE ASSEMBLY	1	

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A10-	201229-1	. . CLAMP, Strain Relief (02660)	1	
	1251-1005	. . GUIDE, Socket	1	
	1251-1006	. . GUIDE, Pin	1	
	201145-3	. . CONTACT (02660)	3	
	201142-2	. . SPRING, Extension (02660)	3	
	328664	. . FERRULE (02660)	3	
	201674-1	. . SPRING, Locking (02660)	2	
	201597-1	. . CONNECTOR, Plug (02660)	1	
-22	07850-61010	. GALVANOMETER ASSEMBLY	1	

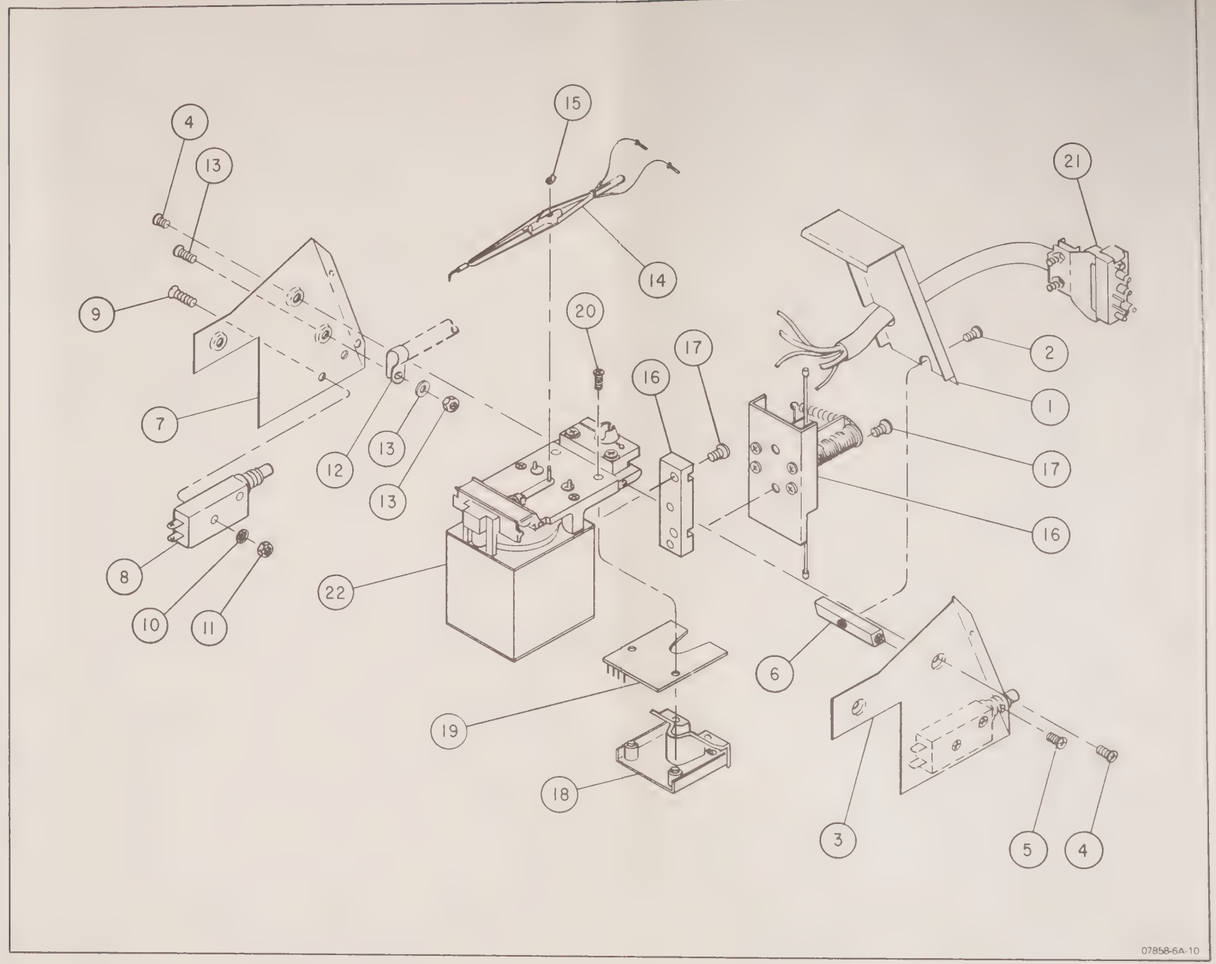


Figure 6A10 Galvanometer Module Assembly, 07850-61000

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A11-	07850-61100	PREAMPLIFIER P.C. ASSEMBLY (see Figure 6A10-19 for NHA)	Ref.	
-1	WMF2S22	. CAPACITOR, Fxd, my .022μF, 200 Vdcw (14655)	1	
-2	NLW10-10	. CAPACITOR, Fxd, elect 10μF, 10 Vdcw (14655)	1	
-3	CB1025	. RESISTOR, Fxd, comp 1K 5% 1/4W (01121)	1	
-4	CB1045	. RESISTOR, Fxd, comp 100K, 5% 1/4W (01121)	1	
-5	CB2245	. RESISTOR, Fxd, comp 220K, 5% 1/4W (01121)	1	
-6	CB3325	. RESISTOR, Fxd, comp 3.3K 5% 1/4W (01121)	1	
-7	CB4705	. RESISTOR, Fxd, comp 47Ω 5% 1/4W (01121)	1	
-8	CB4715	. RESISTOR, Fxd, comp 470Ω, 5% 1/4W (01121)	1	
-9	CB4745	. RESISTOR, Fxd, comp 470K, 5% 1/4W (01121)	1	
-10	CB5625	. RESISTOR, Fxd, comp 5.6K, 5% 1/4W (01121)	1	
-11	CB6225	. RESISTOR, Fxd, comp 6.2K, 5% 1/4W (01121)	1	
-12	EB9105	. RESISTOR, Fxd, comp 91 Meg, 5% 1/2W (01121)	1	
-13	3230-1	. CONNECTOR, Jack (71279)	1	
-14	2N3393	. TRANSISTOR, NPN (03508)	1	
-15	F1064	. TRANSISTOR, Silicon (20638)	1	
-16	752-459	. BOARD, P.C.	1	

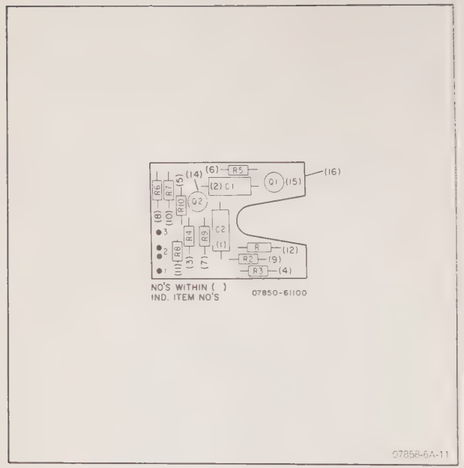
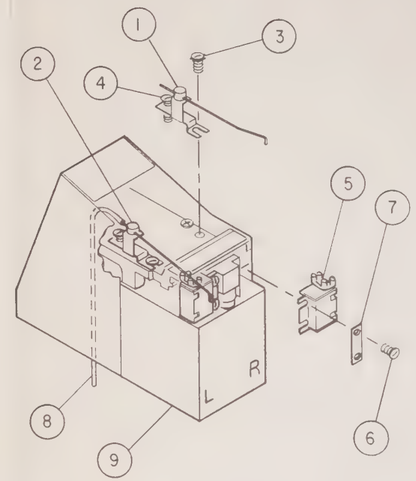


Figure 6A11 Preamplifier P.C. Assembly, 07850-61100

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A12-	07850-61001	GALVANOMETER MODULE ASSEMBLY, L. H. Marker (see Figure 6A9-3 for NHA)	Ref.	
	07850-61002	GALVANOMETER MODULE ASSEMBLY, R. H. Marker (see Figure 6A9-4 for NHA)	Ref.	
-1	07850-61182	. MARKER PEN ASSEMBLY, R. H.	1	
-2	07850-61181	. MARKER PEN ASSEMBLY, L. H.	1	
		(ATTACHING PARTS for -1 & -2)		
-3	2200-0101	. SCREW, Machine 4-40 x 3/16 SEMS	1	
-4	83A-256-6B	. SCREW, Machine 2-56 x 3/8 SEMS	1	
		---*---		
-5	07850-61140	. MARKER COIL ASSEMBLY	1	
		(ATTACHING PARTS)		
-6	0520-0174	. SCREW, Machine 2-56 x 1/4 SEMS	2	
-7		. PLATE, Retainer	1	
		---*---		
-8	07850-21450	. MARKER INK LINE	1	
-9	07850-61000	. GALVANOMETER MODULE ASSEMBLY (see Figure 6A10 for breakdown)	2	



07858-6A-12

Figure 6A12 Galvanometer Module Assembly, L. H. & R. H., 07850-61001 & 07850-61002

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A13-	07858-67040	INK SUPPLY ASSEMBLY (see Figure 6A1-7 for NHA)	Ref.	
		(ATTACHING PARTS)		
-1	2510-0043	. SCREW, Machine, 8-32 x 5/16	1	
		---*---		
-2	07858-67050	. REGULATOR ASSEMBLY		
		(ATTACHING PARTS)		
-3	2360-0121	. SCREW, Machine, 6-32 x 1/2	6	
		---*---		
	07858-67220	. FILTER ASSEMBLY	1	
-4	07858-67240	. . FILTER CAP ASSEMBLY	1	
		(ATTACHING PARTS)		
-5	80A-256-12B	. . SCREW, Machine, 2-56 x 3/4	4	
		---*---		
-6	07858-27400	. . SCREEN, Filter	1	
-7	0905-0090	. . "O" RING, Silicone	1	
-8	07858-67230	. . BODY ASSEMBLY, Filter	1	
-9	07858-07060	. . BRACKET, Filter	1	
	07858-67090	. INK CONTAINER ASSEMBLY	1	
-10	07858-67160	. . CAP ASSEMBLY	1	
-11	07858-07150	. . BRACKET, Ink Container	1	
-12	0400-0120	. . GROMMET	2	
-13	0590-0440	. . NUT, Hex No. 6-32	2	
-14	07858-27180	. . SHAFT	1	
		(ATTACHING PARTS)		
-15	0510-1049	. . RING, Retaining	1	
-16	2950-0103	. . NUT, Hex	1	
-17	2190-0754	. . WASHER, Flat 3/8ID	1	
		---*---		
-18	07858-27360	. . FITTING, Partition	1	
-19	07858-67070	. . CONTAINER ASSEMBLY	1	
-20	07858-67060	. SUPPLY BOTTLE ASSEMBLY	1	
-21	07858-67140	. DRIP TRAY ASSEMBLY	1	

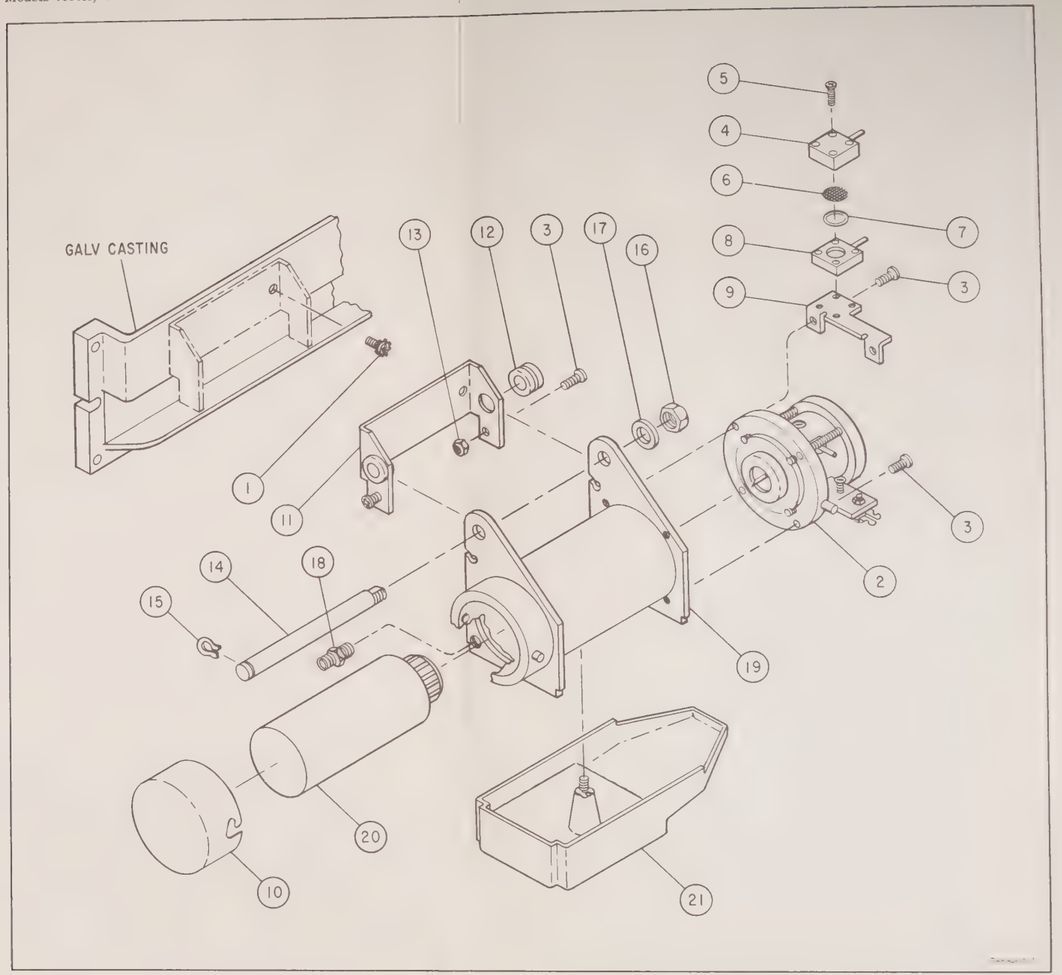


Figure 6A13 Ink Supply Assembly, 07858-67040

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A14-	07858-64000	POWER SUPPLY ASSEMBLY (see Figure 6A1-6 for NHA).	Ref.	
-1	07858-04060	. COVER, P.C. Board	1	
		(ATTACHING PARTS)		
-2	2510-0043	. SCREW, Machine 8-32 x 5/16 SEMS.	2	
		---*---		
-3	07858-64030	. POWER SUPPLY P.C. ASSEMBLY (see Figure 6A16 for breakdown) .	1	
		(ATTACHING PARTS)		
-4	2200-0107	. SCREW, Machine 4-40 x 3/8 SEMS	7	
-5	0380-0338	. SPACER	5	
		---*---		
-6	7486G	. CONNECTOR, Twistlock (74545).	1	
		(ATTACHING PARTS)		
-7	2360-0013	. SCREW, Machine 6-32 x 1/4 SEMS	8	
-8	0590-0419	. NUT, Pem 40P-6-2	2	
		---*---		
-9	200512-2	. CONNECTOR, Receptacle (02660)	3	
-10	1251-1682	. CONNECTOR, Receptacle	1	
-11	201675-1	. CATCH, Locking Spring (02660)	6	
-12	1251-1694	. CATCH, Locking Spring	2	
-13	9100-2011	. TRANSFORMER, Power	1	
		(ATTACHING PARTS)		
-14	2950-0045	. NUT, Hex 1/4-20	4	
-15	2190-0741	. WASHER, Lock	4	
		---*---		
-16	9100-2089	. COIL, Dual Choke	1	
		(ATTACHING PARTS)		
-17	2820-0001	. NUT, Hex 10-32	4	
-18	2190-0812	. WASHER, Lock	4	
		---*---		
-19	71QE2232	. CAPACITOR, Fxd, elect 6400 μF+100 -10% 50 Vdc W/9260-7 (00656)	2	
-20	0490-0433	. RELAY	1	
-21	07858-64060	. MARKER AMPLIFIER P.C. ASSEMBLY (see Figure 6A15 for breakdown)	2	
		(ATTACHING PARTS)		
-22	2360-0015	. SCREW, Machine 6-32 x 5/16 SEMS.	4	
		---*---		
	07858-64020	. TIMER MARKER ASSEMBLY, 60Hz	1	
-23	117P-60RPM	. . MOTOR, Sync. 60RPM, 60Hz (14907).	1	
		(ATTACHING PARTS)		
-24	2360-0015	. . SCREW, Machine 6-32 x 5/16 SEMS	2	
		---*---		

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A14-25	752-417	. BOARD, P.C.	2	
	0490-0437	. . SWITCH, Reed	2	
	SR1358-8	. . SEMICONDUCTOR DEVICE, Diode (04713)	2	
-26	326-19-03-076	. . TERMINAL STRIP (71785)	1	
		(ATTACHING PARTS)		
-27	83A-4-10B	. . SCREW, Machine	2	
		---*---		
-28	14002-60010	. . ACTUATOR ASSEMBLY	2	
		(ATTACHING PARTS)		
-29	0570-0157	. . SETSCREW, Bristol	2	
		---*---		
-30	117P1RPM	. . MOTOR, Sync. 1RPM, 60 Hz (14907)	1	
-31	126-217	. . CONNECTOR, Plug 5 pin (02660)	1	
-32	07858-04050	. . BRACKET, Timer	1	
-33	0340-0196	. COVER, Transistor	2	
-34	2N2869/2N301	. TRANSISTOR, PNP Power (02735)	2	
		(ATTACHING PARTS)		
-35	84D-6-6P	. SCREW, self threading	4	
-36	1200-0043	. . WASHER, Insulated	2	
		---*---		
-37	126-218	. CONNECTOR, Receptacle 5 pin w/hardware (02660)	1	
-38	SD-610S	. CONNECTOR, Receptacle, 10 pin (95354)	2	
		(ATTACHING PARTS)		
-39	2200-0109	. SCREW, Machine 4-40 x 7/16 SEMS	4	
		---*---		
-40	200838-2	. CONNECTOR, Receptacle (02660)	1	
-41	1251-1005	. GUIDE, Socket	5	
-42	1251-1006	. GUIDE, Pin	5	
-43	1251-1803	. CATCH, Locking Spring	2	
-44	5JX100	. FILTER, RFI (56289)	2	
-45	07858-04130	. BRACKET, Filter mfg	1	
		(ATTACHING PARTS)		
-46	2510-0045	. SCREW, Machine 8-32 x 3/8 SEMS	2	
		---*---		
-47	07858-64100	. CABLE ASSEMBLY	1	
-48	1N4721	. SEMICONDUCTOR DEVICE, Diode (04713)	2	
-49	0360-1418	. TERMINAL, Standoff	1	
		(ATTACHING PARTS)		
-50	2200-0103	. SCREW, Machine 4-40 x 1/4 SEM	1	
		---*---		

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A14-51	1N3210	. SEMICONDUCTOR DEVICE, Diode w/o hardware (04713)	4	
-52	0360-1363	. TERMINAL, Lug	4	
-53	133-32-10-024	. SOCKET, Transistor (71785)	2	
-54	77-MIP-11-1009	. SOCKET, Relay (02660)	1	

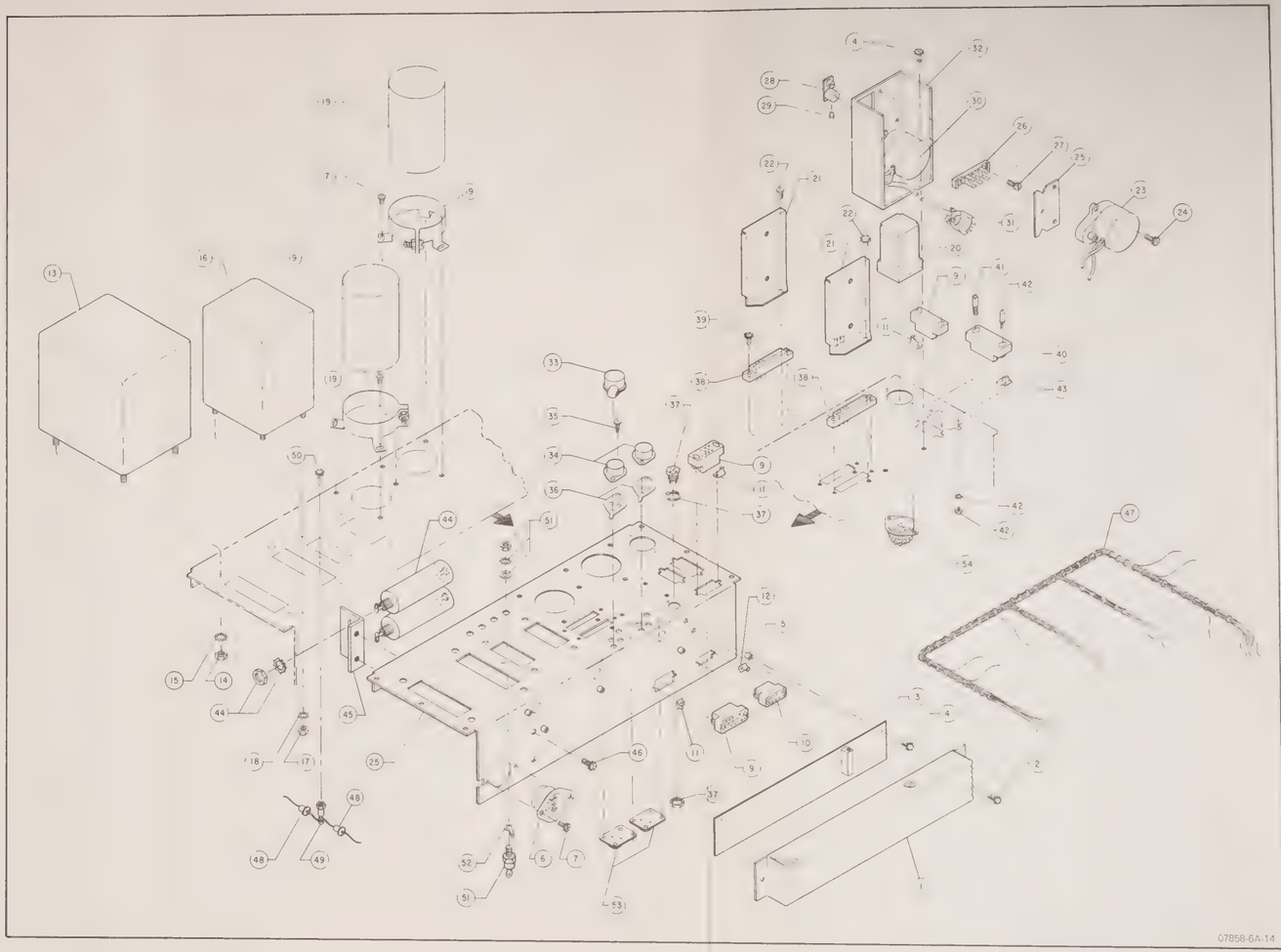


Figure 6A14 Power Supply Assembly, 07858-64000

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A15-	07858-64060	MARKER AMPLIFIER P.C. ASSEMBLY (see Figure 6A14 for NHA)	Ref.	
-1	30D206G050CC 2	. CAPACITOR, Fxd, elect 20μF +75 -10% 50 Vdc (56289)	1	
-2	EB1015	. RESISTOR, Fxd, comp 100Ω 5% 1/2W (01121)	2	
-3	EB1025	. RESISTOR, Fxd, comp 1K 5% 1/2W (01121)	1	
-4	EB1035	. RESISTOR, Fxd, comp 10K 5% 1/2W (01121)	2	
-5	EB1045	. RESISTOR, Fxd, comp 100K 5% 1/2W (01121)	1	
-6	EB1525	. RESISTOR, Fxd, comp 1.5K 5% 1/2W	1	
-7	EB2215	. RESISTOR, Fxd, comp 220Ω 5% 1/2W	1	
-8	2N1131	. TRANSISTOR, Silicon PNP (01295)	1	
-9	2N3053	. TRANSISTOR, NPN (02735)	2	
-10	SR1358-8	. SEMICONDUCTOR DEVICE, Diode (04713)	4	
-11	07858-04080	. BRACKET, Marker Amplifier Board	1	
-12	752-375	. BOARD, P.C.	1	

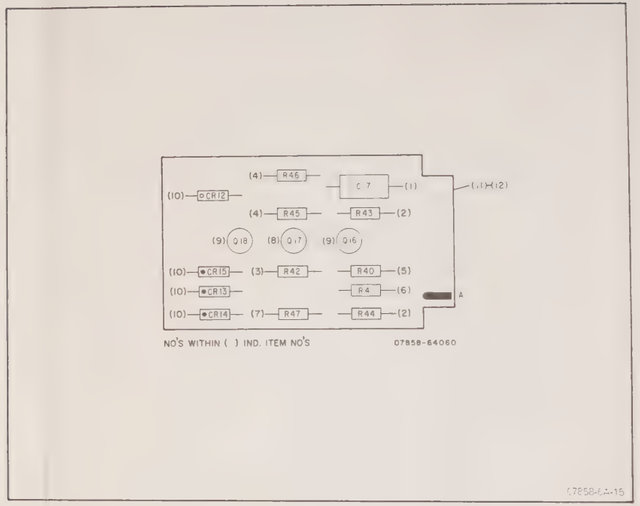


Figure 6A15 Marker Amplifier P.C. Assembly, 07858-64060

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A16-	07858-64030	POWER SUPPLY P.C. ASSEMBLY (see Figure 6A14- for NHA)	Ref.	
-1	192P10352-PTS	. CAPACITOR, Fxd, my .01μF 200V (56289)	1	
-2	841-Z5V-203P	. CAPACITOR, Fxd, ceramic .024μF +80 -20% 500Vdc (72982)	1	
-3	114P1042R5S4	. CAPACITOR, Fxd, .1μF, 2% 50V (56289)	1	
-4	WMT1P1	. CAPACITOR, Fxd, my .1μF 100Vdc (14655)	2	
-5	NLW100-12	. CAPACITOR, Fxd, elect 100μF, 12V (14655)	1	
-6	NLW200-15	. CAPACITOR, Fxd, elect, 200μF 15Vdcw (14655)	3	
-7	ECPA10003	. CAPACITOR, Fxd, elect 1μF +150 -10% 50Vdc (14655)	1	
-8	CB2225	. RESISTOR, Fxd, comp 2.2K 5% 1/4W (01121)	2	
-9	CB4715	. RESISTOR, Fxd, comp 470 Ω 5% 1/4W (01121)	1	
-10	CB4725	. CAPACITOR, Fxd, comp 4.7K 5% 1/4W (01121)	2	
-11	EB1005	. RESISTOR, Fxd, comp 10 Ω 5% 1/2W (01121)	1	
-12	EB1035	. RESISTOR, Fxd, comp 10K 5% 1/2W (01121)	2	
-13	EB1515	. RESISTOR, Fxd, comp 150 Ω 5% 1/2W (01121)	1	
-14	EB1525	. RESISTOR, Fxd, comp 1.5K 5% 1/2W (01121)	1	
-15	EB2205	. RESISTOR, Fxd, comp 22 Ω 5% 1/2W (01121)	1	
-16	EB3925	. RESISTOR, Fxd, comp 3.9K 5% 1/2W (01121)	1	
-17	EB4715	. RESISTOR, Fxd, comp 470 Ω 5% 1/2W (01121)	1	
-18	EB4725	. RESISTOR, Fxd, comp 4.7K 5% 1/2W (01121)	1	
-19	EB5125	. RESISTOR, Fxd, comp 5.1K 5% 1/2W (01121)	1	
-20	EB6825	. RESISTOR, Fxd, comp 6.8K 5% 1/2W (01121)	1	
-21	EB8225	. RESISTOR, Fxd, comp 8.2K 5% 1/2W (01121)	1	
-22	0698-5966	. RESISTOR, Fxd, film 5K 1% 1/2W	1	
-23	MF7C	. RESISTOR, Fxd, film 3.48meg 1% 1/2W (19701)	1	
-24	MF7C T-O	. RESISTOR, Fxd, film 500 Ω 1% 1/2W (19701)	3	
-25	CEC T-O	. RESISTOR, Fxd, film 100 Ω 1% 1/2W (75042)	2	
-26	MF7C T-O	. RESISTOR, Fxd, film 909 Ω 1% 1/2W (19701)	1	
-27	MF7C T-O	. RESISTOR, Fxd, film 6K 1% 1/2W (19701)	1	
-28	C32	. RESISTOR, Fxd, film 1K 5% 1W (07115)	1	
-29	C32	. RESISTOR, Fxd, film 330 Ω 5% 1W (07115)	2	
-30	242E	. RESISTOR, Fxd, WW 20Hms 5% 3W (56289)	1	
-31	0811-2177	. RESISTOR, Fxd, 800 Ω 1%	1	
-32	1010-0005	. METER, Elapsed Time	1	
-33	2N1307	. TRANSISTOR, Ge PNP (01295)	1	
-34	SKA1123	. TRANSISTOR, SM9143 (01295)	5	
-35	2N3053	. TRANSISTOR, Silicon NPN (02735)	2	
-36	2N3393	. TRANSISTOR, Silicon NPN (03508)	1	
-37	1902-0177	. SEMICONDUCTOR DEVICE, Diode 9.5V	1	
-38	1902-0556	. SEMICONDUCTOR DEVICE, Diode 19.5V	2	

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A16-39	1902-0558	. SEMICONDUCTOR DEVICE, Diode 12V	1	
-40	D2361	. SEMICONDUCTOR DEVICE, Diode (04651)	3	
-41	275-1-501	. RESISTOR, Variable 500 ohms 10% 1/4W (80294)	1	
-42	9100-2091	. INDUCTOR, Toroidal	1	
-43	752-368	. BOARD, p.c.	1	

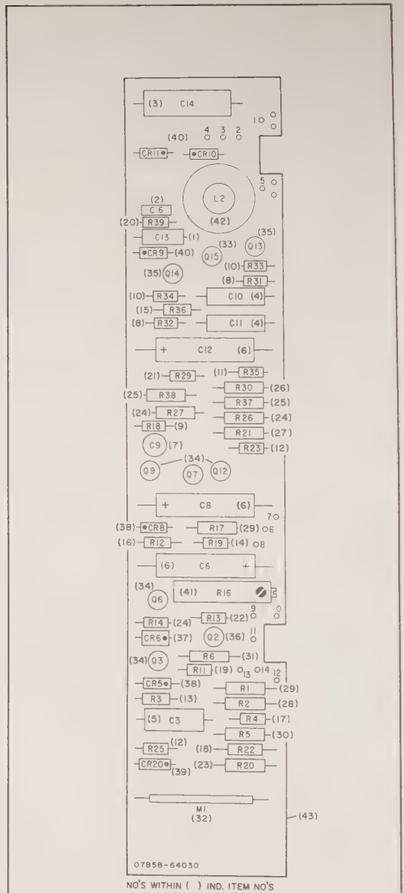


Figure 6A16 Power Supply P.C. Assembly, 07858-64030

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A17-	07858-68000	TABLE ASSEMBLY (see Figure 6A1-8 for NHA)	Ref.	
-1	07858-21370	. COVER, Sprocket	1	
		(ATTACHING PARTS)		
-2	2200-0169	. SCREW, Machine, 4-40 x 1/2	2	
		---*---		
-3	1500-0721	. CHAIN, Drive	1	
-4	MAC-100	. SWITCH, Sensitive SPDT (10594)	1	
-5	07858-41040	. BASE, Switch	1	
		(ATTACHING PARTS)		
-6	2200-0166	. SCREW, Machine 4-40 x 5/16	8	
-7	0590-0199	. NUT, Hex 4-40 Keps	8	
		---*---		
-8	07858-61100	. TOP PAPER BRAKE ASSEMBLY	1	
-9	07858-21110	. ROD, Stiffener	1	
		(ATTACHING PARTS)		
-10	2360-0129	. SCREW, Machine 6-32 x 1 in.	3	
		---*---		
-11	1460-0838	. SPRING, Cable Brake	1	
-12	07858-61201	. STYLUS PROTECTION ASSEMBLY, L.H.	1	
		(ATTACHING PARTS)		
-13	83D-1032-8V	. BOLT, Hex hd 10-32 x 1/2	4	
-14	3050-0019	. WASHER, Flat 10-32	4	
		---*---		
	1460-0905	. . SPRING, Stylus Protection	1	
	1460-0906	. . SPRING, Paper Brake	1	
	07858-01130	. . CAM, Left	1	
	07858-01160	. . CAM, Stylus Protection	1	
	07858-21240	. . NUT, Pivot	2	
	07858-21260	. . SPACER, Pivot	2	
	07858-61220	. . LEFT PIVOT ASSEMBLY	1	
	07858-01020	. . . PIVOT, Stylus Protection	1	
	07858-21500	. . . STUD, Pivot	2	
-15	07858-21250	. BUTTON	2	
-16	07858-61202	. STYLUS PROTECTION ASSEMBLY, R.H.	1	
	1460-0905	. . SPRING, Stylus Protection	1	
	1460-0907	. . SPRING, Paper Brake	1	
	07858-01140	. . CAM, Right	1	
	07858-01160	. . CAM, Stylus Protection	1	
	07858-21240	. . NUT, Pivot	2	
	07858-21260	. . SPACER, Pivot	2	

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A17-	07858-61210	. . RIGHT PIVOT ASSEMBLY	1	
	07858-01010	. . . PIVOT, Stylus Protection	1	
	07858-21500	. . . STUD, Pivot	2	
-17	07858-01050	. BRACKET, Brake	1	
		(ATTACHING PARTS)		
-18	2360-0121	. SCREW, Machine 6-32 x 1/2 SEMS	2	
-19	2360-0183	. SCREW, Machine 6-32 x 3/8	1	
		---*---		
-20	07858-41090	. SHOE, Pressure	1	
-21	1460-0812	. SPRING, Table Brake	2	
-22	07858-21010	. BRACKET, Mounting	1	
-23	3030-0314	. SETSCREW	2	
-24	07858-41120	. BRACKET, Shoe	1	
		(ATTACHING PARTS)		
-25	2360-0185	. SCREW, Machine 6-32 x 1/2.	2	
		---*---		
-26	8300-0002	. CABLE, Brake	1	
-27	07858-41070	. CAM, Brake	1	
-28	07858-21030	. ROLL, Cable	1	
		(ATTACHING PARTS)		
-29	2680-0051	. SCREW, Machine 10-32 x 3/8 SEMS.	1	
-30	07858-21350	. STUD, Cable Roll.	1	
		---*---		
-31	07858-67000	. MOTOR & SPEED CHANGE W/AIR REGULATOR ASSEMBLY (see Figure 6A6 for breakdown).	Ref.	
-32	07858-08060	. GUIDE, Paper		
		(ATTACHING PARTS)		
-33	2510-0041	. SCREW, Machine 8-32 x 1/4 SEMS	2	
		---*---		
-34	07858-68130	. ROLLED PAPER BRAKE ASSEMBLY	1	
-35	07850-68090	. PRESSURE DRIVE ROLL ASSEMBLY	1	
		(ATTACHING PARTS)		
-36	0570-0159	. SETSCREW 8-32 x 3/16	3	
		---*---		
	1410-0886	. . BEARING	2	
	07858-28460	. . SPRING	2	
	07858-28400	. . HOUSING, Bearing	2	
	07858-08160	. . ROLLER.	7	
	07858-28500	. . SHAFT.	2	
-37	4040-0292	. CONDUCTOR, Static	1	

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A17-38	07858-28030	. RETAINER	1	
		(ATTACHING PARTS)		
-39	2200-0103	. SCREW, Machine 4-40 x 1/4 SEMS	4	
		---*---		
-40	1430-0460	. SPROCKET	1	
		(ATTACHING PARTS)		
-41	0510-1054	. KEY, Woodruff	1	
		---*---		
-42	07858-68200	. BEARING RETAINER ASSEMBLY, L.H.	1	
-43	2190-0844	. WASHER, Wavy	1	
-44	1410-0739	. BEARING, Ball	2	
-45	07858-08210	. SPRING, Supply Roll	1	
-46	07858-68040	. SUPPLY ROLL ASSEMBLY	1	
-47	07858-28390	. SPOOL, P.T.U.	1	
-48	07858-68060	. SHAFT ASSEMBLY, P.T.U.	1	
-49	07858-68010	. SWITCH RELEASE ASSEMBLY	1	
		(ATTACHING PARTS)		
-50	0510-0052	. RING, Retaining	3	
		---*---		
-51	07858-68151	. LATCH ASSEMBLY, R.H.	1	
-52	07858-68152	. LATCH ASSEMBLY, L.H.	1	
-53	1460-0967	. SPRING	2	
-54	07858-28331	. LEVER, L.H.	1	
-55	07858-28332	. LEVER, R.H.	1	
		(ATTACHING PARTS for -54 and -55)		
-56	0570-0169	. SETSCREW, 4-40 x 3/8	2	
		---*---		
-57	07858-68020	. PLATEN ASSEMBLY	1	
		(ATTACHING PARTS)		
-58	0570-0197	. SETSCREW, 4-40	2	
		---*---		
-59	07858-28300	. NUT, Torsion Rod	2	
-60	07858-28040	. PIN, Platen	2	
-61	07858-28060	. TORSION ROD	2	
-62	2510-0158	. SCREW, Nylock	2	
-63	07858-68080	. DRIVE ROLL ASSEMBLY	1	
		(ATTACHING PARTS)		
-64	2190-0757	. WASHER, Flat 6-32	2	
-65	1460-0992	. SPRING	1	
-66	1460-0993	. SPRING	1	

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A17-67	07858-28530	. KEY	1	
		---*---		
-68	07858-68100	. GEAR PLATE MOUNTING ASSEMBLY	1	
		(ATTACHING PARTS)		
-69	2680-0118	. SCREW, Machine 10-32 x 1/2	3	
-70	2740-0003	. NUT, Keps 10-32	3	
		---*---		
-71	07858-28470	. PLATE, Clutch	1	
-72	07858-48010	. RING, Clutch	1	
-73	5020-5605	. GEAR, Drive Shaft	1	
-74	1410-0170	. BEARING, Ball	1	
-75	07858-68190	. BEARING RETAINER ASSEMBLY, R.H.	1	
-76	07858-28520	. WASHER.	1	
-77	07858-08070	. SPRING, Supply Roll	1	
		(ATTACHING PARTS)		
-78	0520-0185	. SCREW, Machine 2-56 x 1/8 SEMS	1	
		---*---		
-79	07858-28350	. RETAINER	2	
		(ATTACHING PARTS)		
-80	2200-0168	. SCREW, Machine 4-40 x 7/16	4	
		---*---		
-81	07858-28340	. TIE BAR.	1	
-82	07858-08010	. SPRING, Table	1	
		(ATTACHING PARTS)		
-83	2200-0101	. SCREW, Machine 4-40 x 3/16 SEMS.	2	
-84	2190-0756	. WASHER, Flat 4-40	2	
		---*---		
-85	07858-28010	. GUIDE, Interlock	1	
		(ATTACHING PARTS)		
-86	0520-0174	. SCREW, Machine 2-56 x 1/4 SEMS	2	
		---*---		
-87	07858-68030	. TABLE ASSEMBLY.	1	

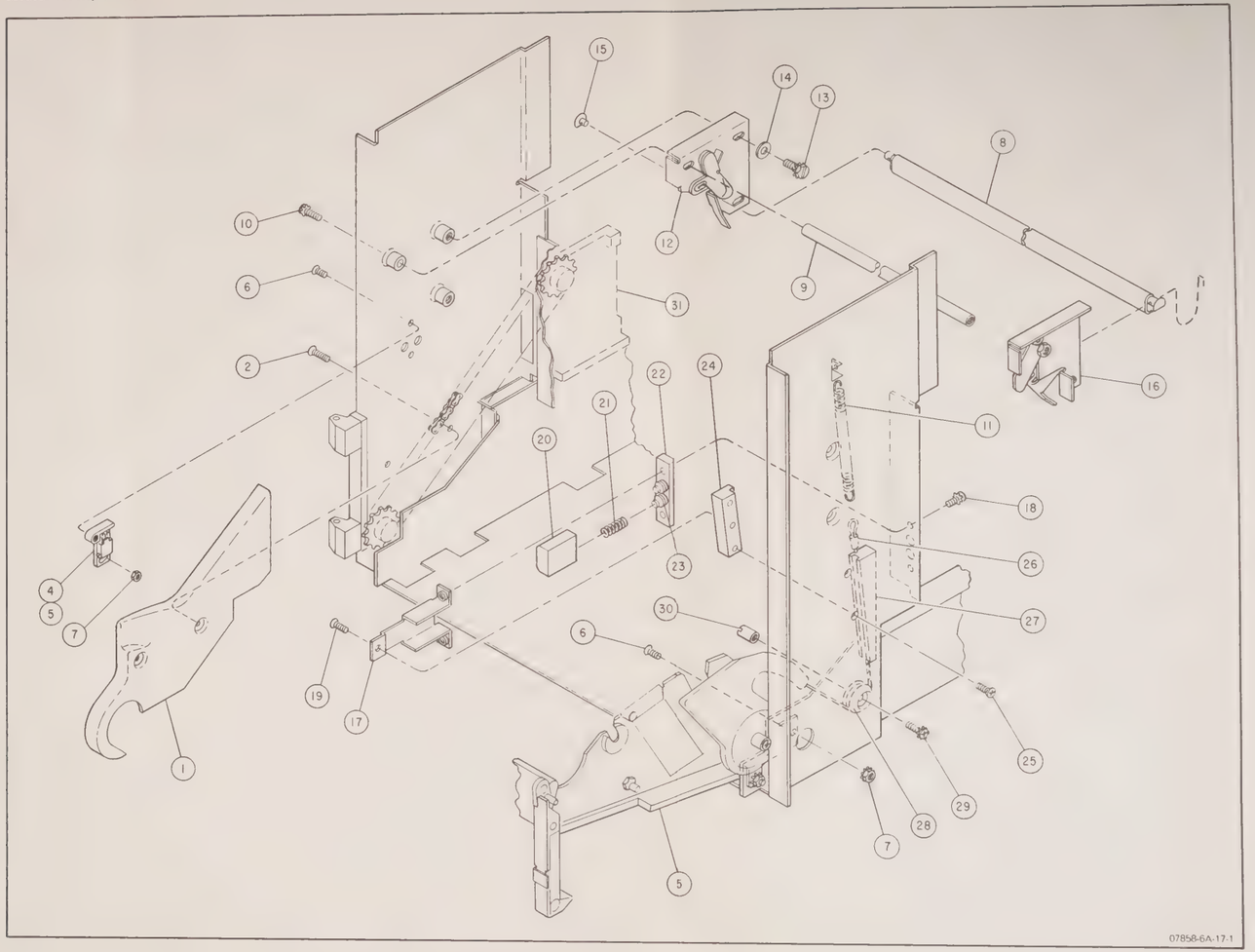


Figure 6A17 Table Assembly, 07858-68000 (sheet 1 of 2)
6A-37/38

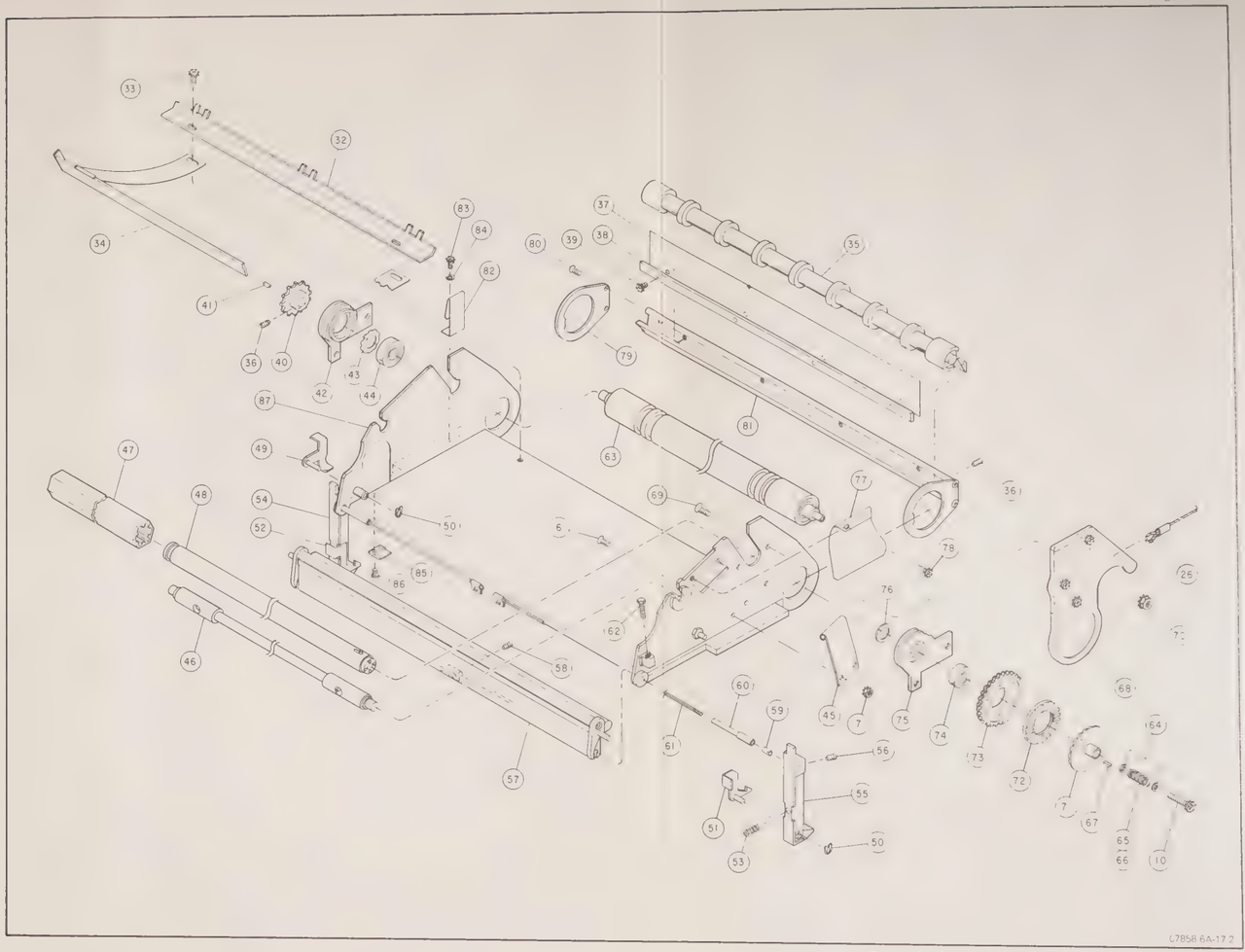


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Figure 6A17 Table Assembly, 07858-68000 (sheet 2 of 2)

Section VI
Group Assembly Parts List

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A18-	Reference	MAIN FRAME & BASE ASSEMBLY, (see Figure 6A1-9 for NHA).	Ref.	
-1	07858-01091	. PLATE, Side, L. H.	1	
		(ATTACHING PARTS)		
-2	2510-0041	. SCREW, Machine 8-32 x 1/4 SEMS.	20	
		---*---		
-3	07858-01092	. PLATE, Side, R. H.	1	
-4	1490-0711	. SLIDES, 1 Pair	1	
		(ATTACHING PARTS)		
-5	2510-0123	. SCREW, Machine 8-32 x 1/2 fl hd	8	
		---*---		
-6	07858-01240	. SPRING, Latch, R. H.	1	
		(ATTACHING PARTS)		
-7	2200-0103	. SCREW, Machine 4-40 x 1/4	2	
-8	01250-21705	. SPACER	2	
		---*---		
-9	07858-21331	. LATCH, Lock, R. H.	1	
		(ATTACHING PARTS)		
-10	838-10	. SCREW, Shoulder	2	
-11	2190-0791	. WASHER, Spring	2	
		---*---		
-12	07858-21340	. SPACER, Latch	2	
-13	07858-01250	. SPRING, Latch, L. H.	1	
-14	07858-21332	. LATCH, Lock	1	
-15	07858-21310	. HINGE, Door	2	
		(ATTACHING PARTS)		
-16	2200-0107	. SCREW, Machine 4-40 x 3/8 SEMS.	4	
		---*---		
-17	07858-01070	. BRACKET, Lock Pin	1	
		(ATTACHING PARTS)		
-18	2200-0101	. SCREW, Machine 4-40 x 3/16	2	
		---*---		
-19	07858-61110	. BACK ASSEMBLY.	1	
		(ATTACHING PARTS)		
-20	2510-0045	. SCREW, Machine 8-32 x 3/8 SEMS.	2	
		---*---		
-21	07858-21570	. BLOCK, Shipping	2	
		(ATTACHING PARTS)		
-22	2510-0061	. SCREW, Machine 8-32 x 1/4	4	
		---*---		
-23	07858-61180	. CABLE ASSEMBLY	1	

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A18-24	1251-1295	. . CONNECTOR, Receptacle	2	
-25	1251-1291	. . HOOD, Connector	2	
-26	1251-1682	. . CONNECTOR, Receptacle	1	
-27	1251-1006	. GUIDE, Pin	3	
-28	1251-1005	. GUIDE, Socket	3	
-29	1251-1292	. SPRING, Locking	4	
-30	1251-1694	. SPRING, Catch	2	
-31	SD-610S	. CONNECTOR, Receptacle (95354)	8	
		(ATTACHING PARTS)		
-32	2510-0107	. SCREW, Machine 8-32 x 3/8	16	
-33	0590-0438	. NUT, Stop	16	
		---*---		
-34	07858-61170	. CABLE ASSEMBLY	1	
-35	201359-1	. . CONNECTOR, Receptacle (02660)	1	
	1251-1005	. . GUIDE, Socket	1	
	1251-1006	. . GUIDE, Pin	1	
	1251-1695	. . LOCK, Spring (pair)	1	
	1251-1698	. . CLAMP, Strain Relief	1	
-36	7120-1861	. NAMEPLATE	1	
-37	07858-61120	. TRANSFER CHASSIS ASSEMBLY	1	
-38	07858-61010	. BASE ASSEMBLY	1	
	07858-61040	. PAPER GUIDE ASSEMBLY	1	
-39	07858-01700	. . COVER	1	
		(ATTACHING PARTS)		
-40	2360-0115	. . SCREW, Machine 6-32 x 5/16 SEMS	2	
		---*---		
-41	07858-21090	. . BLOCK	2	
		(ATTACHING PARTS)		
-42	2360-0117	. . SCREW, Machine 6-32 x 3/8 SEMS	2	
-43	2190-0757	. . WASHER, Flat 6-32	2	
		---*---		
-44	07858-41080	. . ARM	3	
		(ATTACHING PARTS)		
-45	1480-0252	. . PIN, Roll	3	
		---*---		
-46	07858-21060	. . ROD	1	
-47	07858-61060	. GAUGE PLATE ASSEMBLY	1	
		(ATTACHING PARTS)		
-48	2360-0115	. SCREW, Machine 6-32 x 1/4 SEMS	4	
		---*---		

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A18-49	07858-01690	. . HANDLE, Paper Guide.	1	
		(ATTACHING PARTS)		
-50	2360-0181	. . SCREW, Machine, fl hd 6-32 x 1/4	1	
		---*---		
	07858-01500	. . GAUGE, Folded Paper	1	
	07858-01490	. . HINGE, Bracket	2	
	07858-01150	. . HINGE BLOCK, Plate	2	
	07858-01180	. . HINGE, Gauge Plate	2	
	0510-1052	. . PIN, Cold hd	4	
	07858-61030	. FOLDED PAPER BRAKE ASSEMBLY	1	
-51	07858-21300	. . FRAME, Brake.	2	
		(ATTACHING PARTS)		
-52	2360-0181	. . SCREW, Machine 6-32 x 1/4 fl hd.	2	
		---*---		
-53	07858-41012	. . BLOCK, Brake Frame	2	
		(ATTACHING PARTS)		
-54	2360-0182	. . SCREW, Machine, fl hd 6-32 x 5/16	4	
		---*---		
-55	838-33	. . SCREW, Shoulder	2	
-56	07858-21270	. . STOP, Brake, R.H.	1	
		(ATTACHING PARTS)		
-57	0520-0168	. . SCREW, Machine, fl hd 2-56 x 5/16	2	
-58	2360-0168	. . SCREW, Machine, fl hd 6-32 x 3/8	2	
		---*---		
-59	07858-41020	. . BRAKE, Folded Paper	4	
		(ATTACHING PARTS)		
-60	3030-0303	. . SETSCREW, Nylock	8	
-61	1460-0803	. . SPRING.	8	
		---*---		
-62	07858-21290	. . BRAKE, Paper Shoe	1	
-63	07858-41011	. . BLOCK, Brake Frame.	2	
-64	07858-21280	. . STOP, Brake, L.H.	1	
-65	07858-61080	. PAPER WEIGHT ASSEMBLY	1	
-66	07858-21490	. . ROLLER, Paper Weight	1	
	07858-41050	. . BEARING, Paper Weight.	4	
	07858-01671	. . CATCH, Paper Weight.	1	
	07858-01672	. . CATCH, Paper Weight.	1	
	07858-01680	. . PAPER WEIGHT	1	
-67	07858-21480	. ROD, Paper Weight	1	
		(ATTACHING PARTS)		

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A18-68	2200-0103	. SCREW, Machine 4-40 x 1/4 SEMS	1	
-69	3050-0269	. WASHER, Flat 4-40.	1	
		---*---		
-70	07858-01220	. CLAMP, Spring	1	
		(ATTACHING PARTS)		
-71	2360-0117	. . SCREW, Machine 6-32 x 3 /8 SEMS	1	
-72	2420-0006	. NUT, Keps 6-32	1	
		---*---		
-73	07858-21100	. SPRING, Gauge Plate	1	
-74	1460-0839	. SPRING, Extension	2	
		(ATTACHING PARTS)		
-75	2200-0113	. SCREW, Machine 4-40 x 5/8 SEMS	2	
		---*---		
-76	07858-21620	. BAR, Paper Brake	1	
		(ATTACHING PARTS)		
-77	2200-0166	. SCREW, Machine, fl hd 4-40 x 5/16	4	
		---*---		
-78	07858-21630	. STRIP, Backing	1	
-79	07858-61070	. TRAY ASSEMBLY.	1	
		(ATTACHING PARTS)		
-80	2510-0043	. SCREW, Machine 8-32 x 5 /16 SEMS	4	

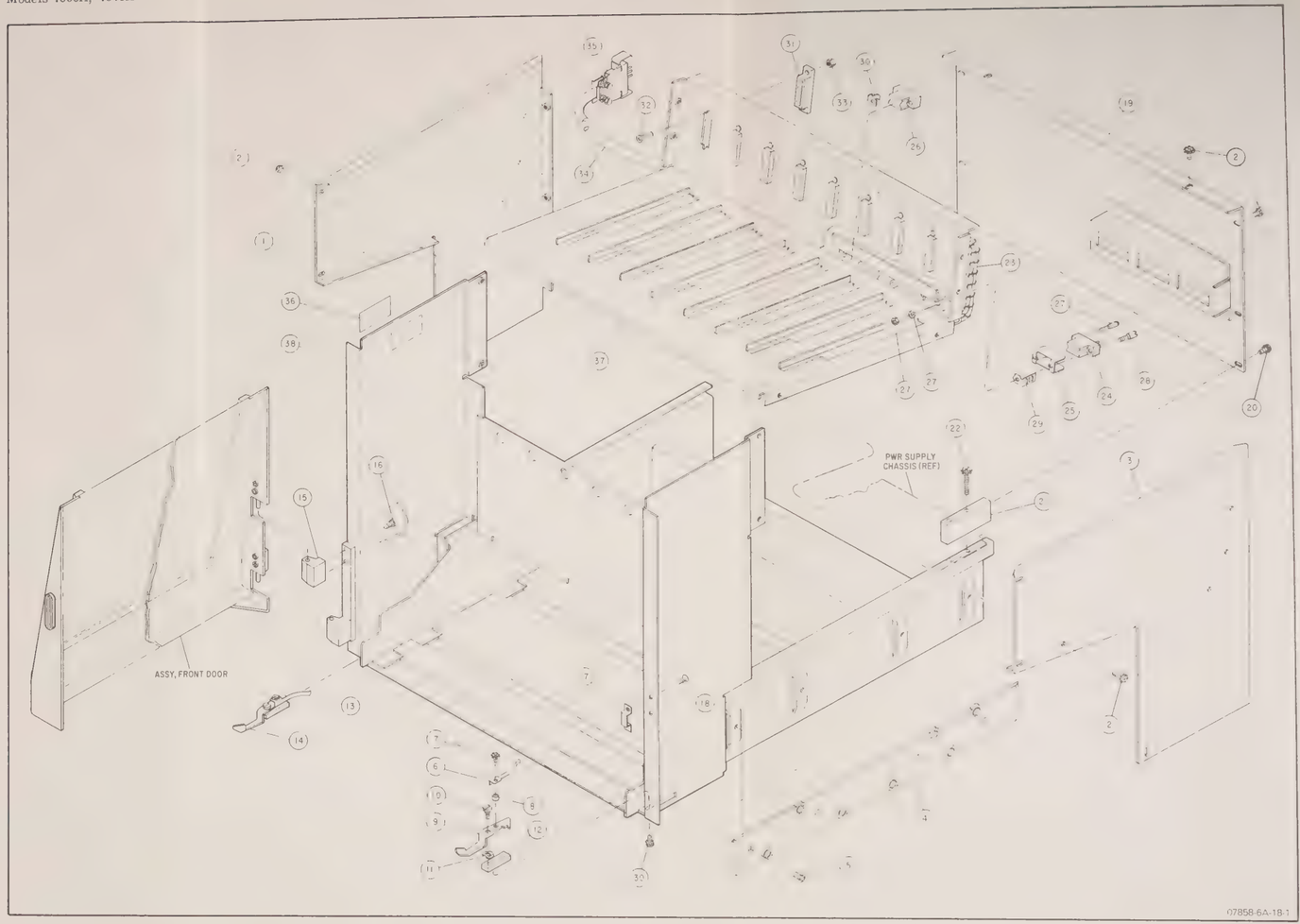


Figure 6A18. Main Frame and Base Assembly Reference (Sheet 1 of 2)

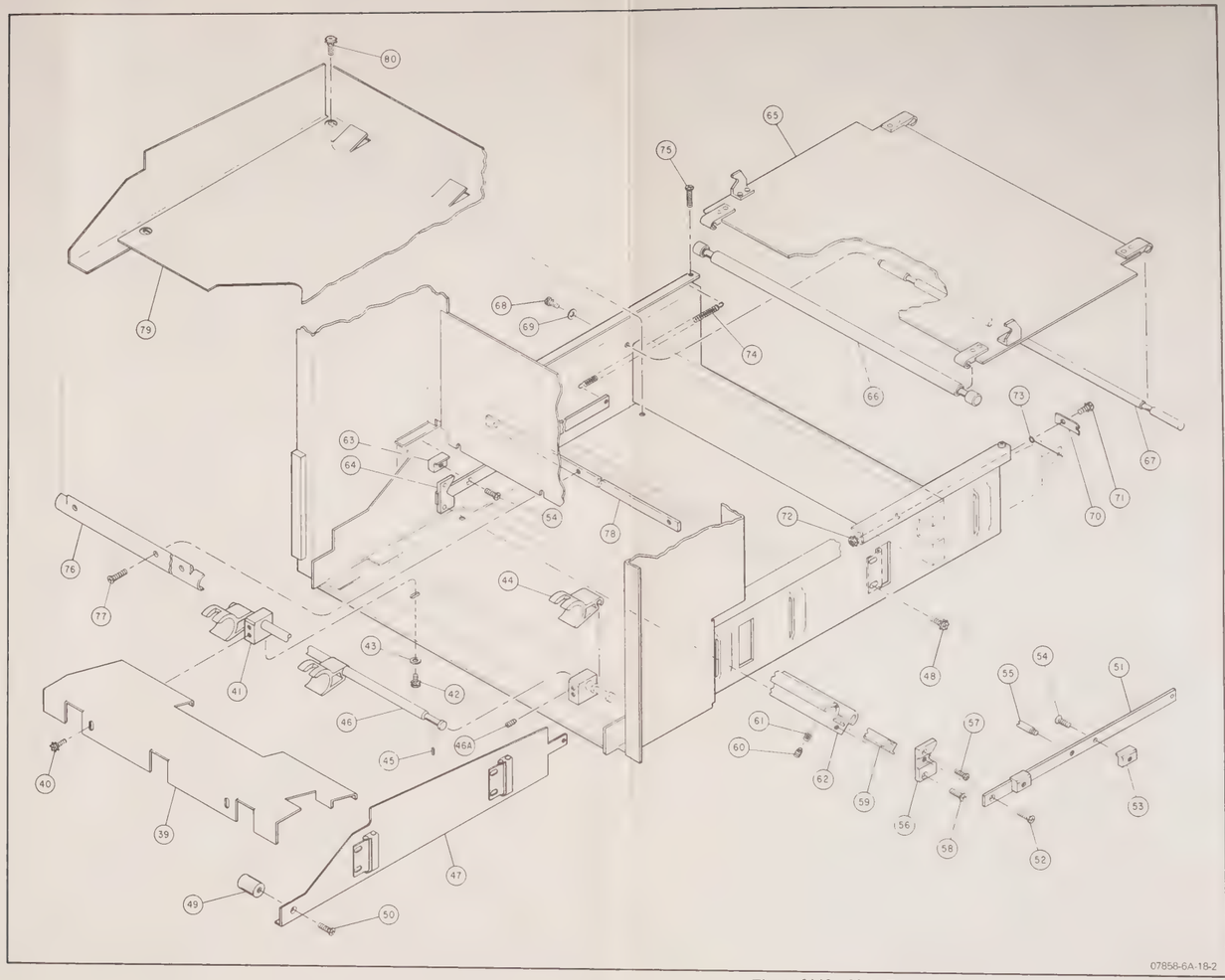


Figure 6A18. Main Frame and Base Assembly Reference (Sheet 2 of 2)

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USE ON CODE
6A19-	07858-61250	FOLDED PAPER DRAWER ASSEMBLY (see Figure 6A1-10 for NHA)	Ref.	
-1	07858-01580	. FILLER STRIP	2	
		(ATTACHING PARTS)		
-2	2680-0107	. SCREW, Machine 10-32 SEMS	4	
-3	2190-0702	. WASHER, Plastic Cup	4	
		---*---		
-4	7101-0096	. DRAWER	1	
		(ATTACHING PARTS)		
-5	2360-0115	. SCREW, Machine 6-32	12	
-6	2420-0006	. NUT, Kep	12	
		---*---		
-7	330	. . SLIDE, Drawer, pair	1	
-8	1460-0914	. SPRING	2	
-9	07858-01650	. SPREADER	1	
-10	07858-01640	. BRACKET, Panel	2	
		(ATTACHING PARTS)		
-11	2360-0183	. SCREW, Machine Fl hd 6-32	2	
-12	07858-21580	. BUSHING	4	
-13	07858-21590	. ROLLER	4	
		---*---		
-14	07858-01590	. BRACKET, Side	2	
		(ATTACHING PARTS)		
-15	84D-6-8B	. SCREW, Self-tapping	2	
-16	2190-0801	. WASHER, Nylon	2	
		---*---		
-17	07858-01570	. PANEL	1	

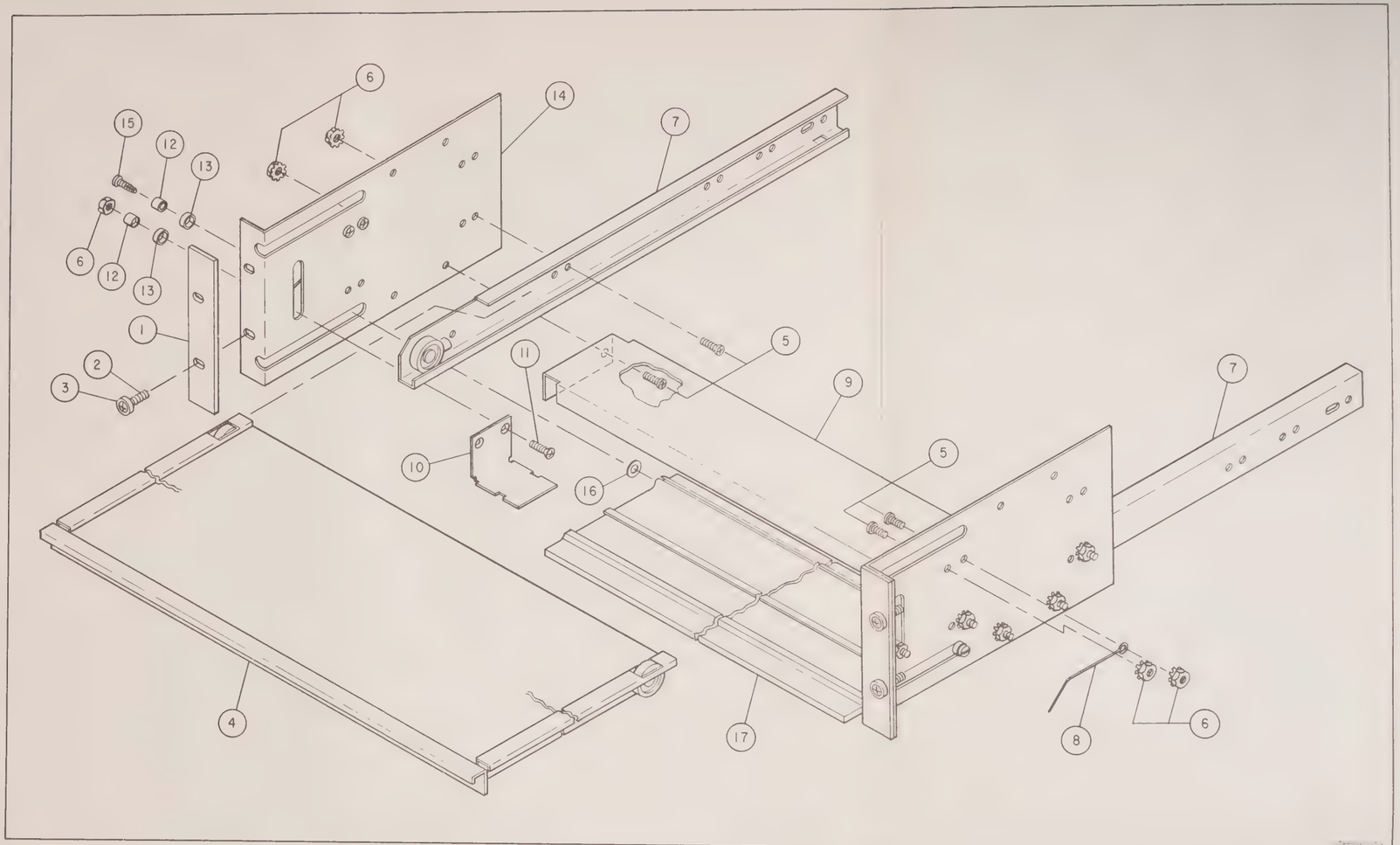


Figure 6A19. Folded Paper Drawer Assembly, 07858-61250

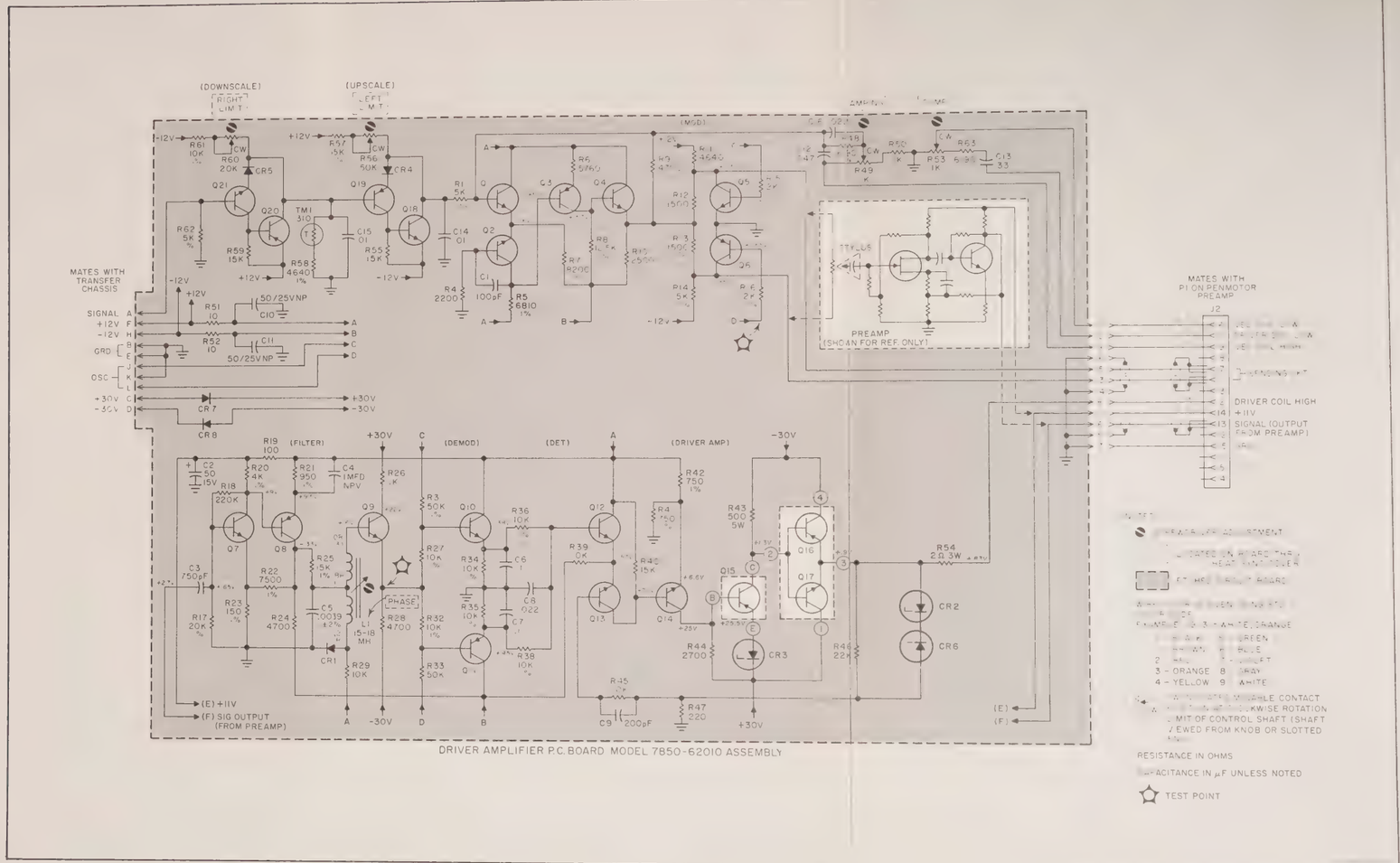


Figure 6A20. Driver Amplifier Schematic for Model 7848A

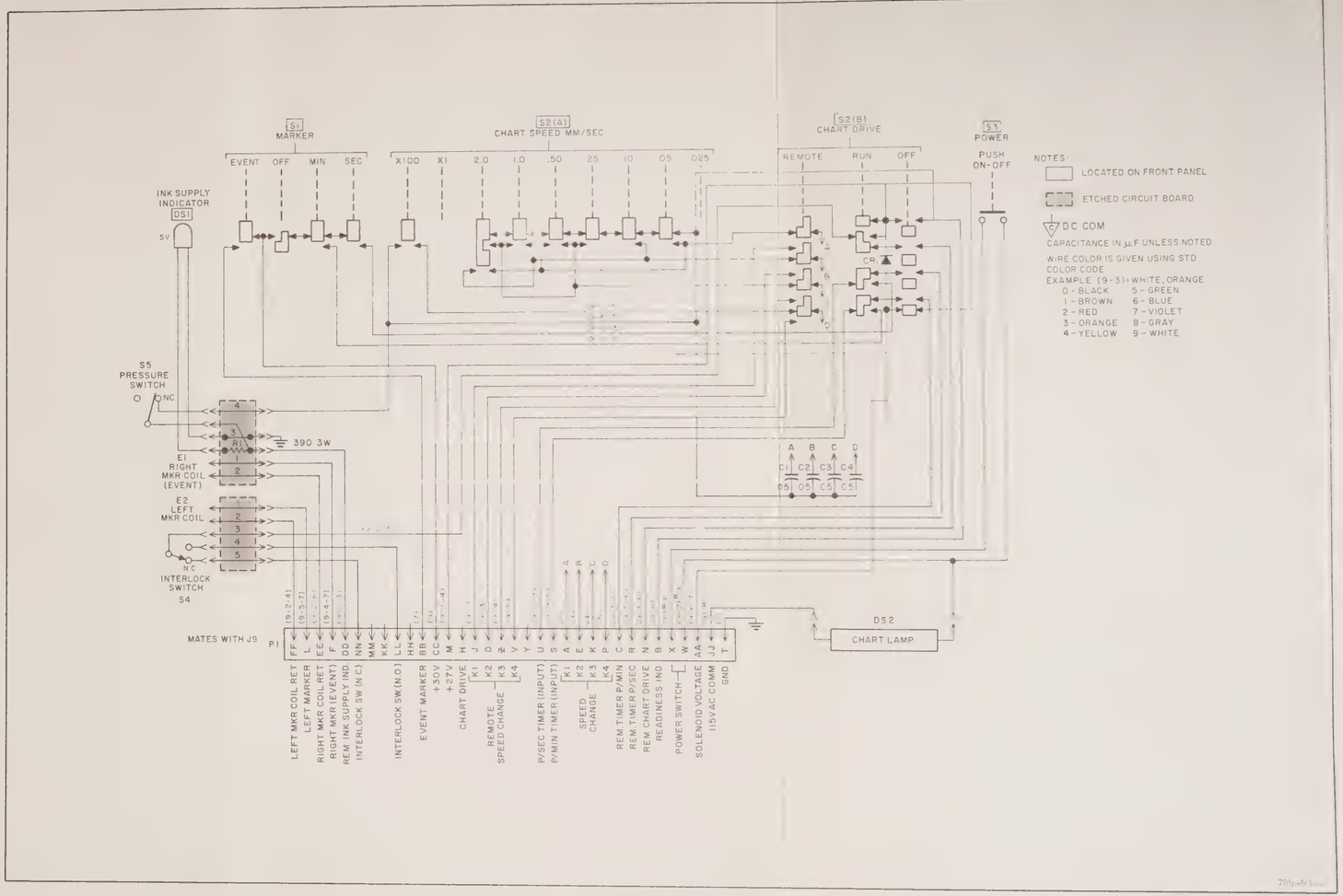


Figure 6A21. Control Panel Schematic for Model 7848A

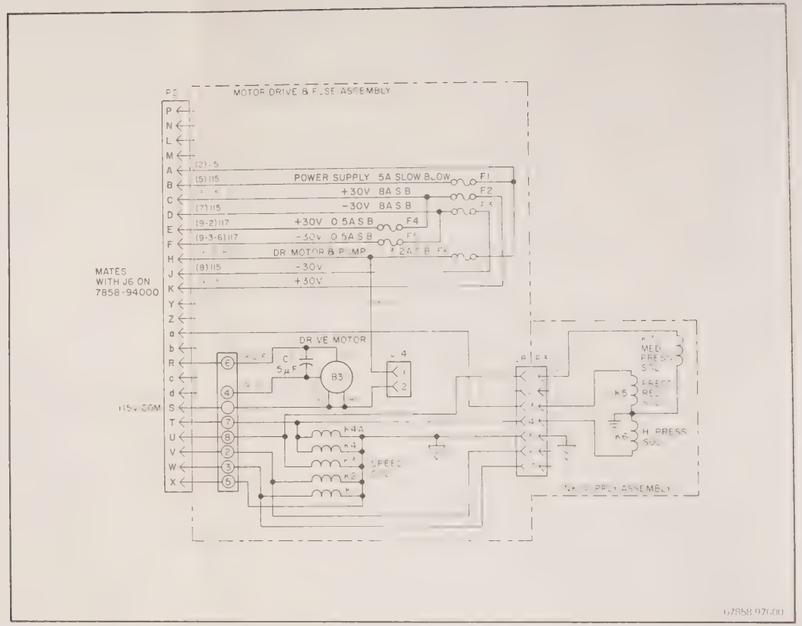


Figure 6A22. Motor Drive, Fuse and Air Regulation Schematic for Model 7848A

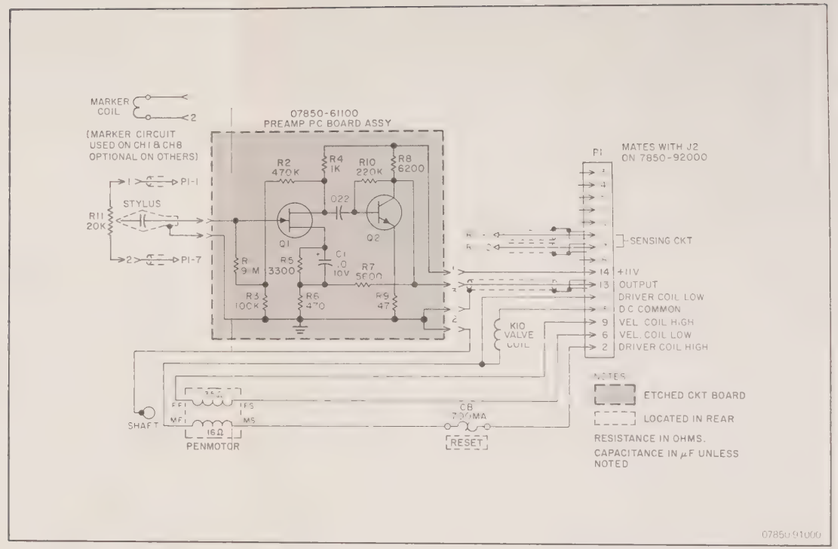
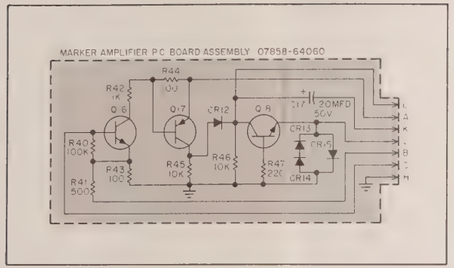


Figure 6A23. Preamplifier and Penmotor Schematic for Model 7848A



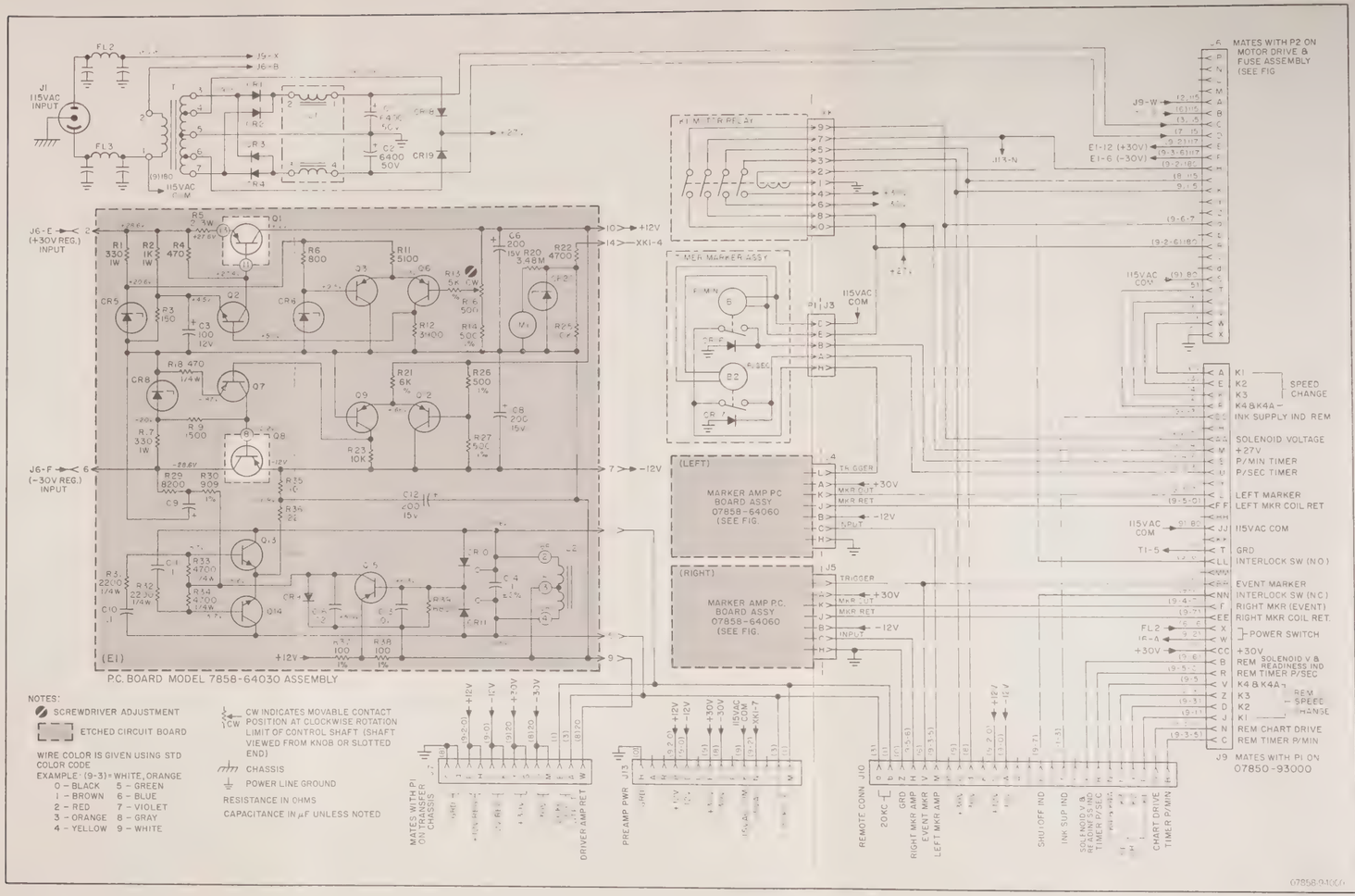


Figure 6A24. Power Supply Schematic for Model 7848A

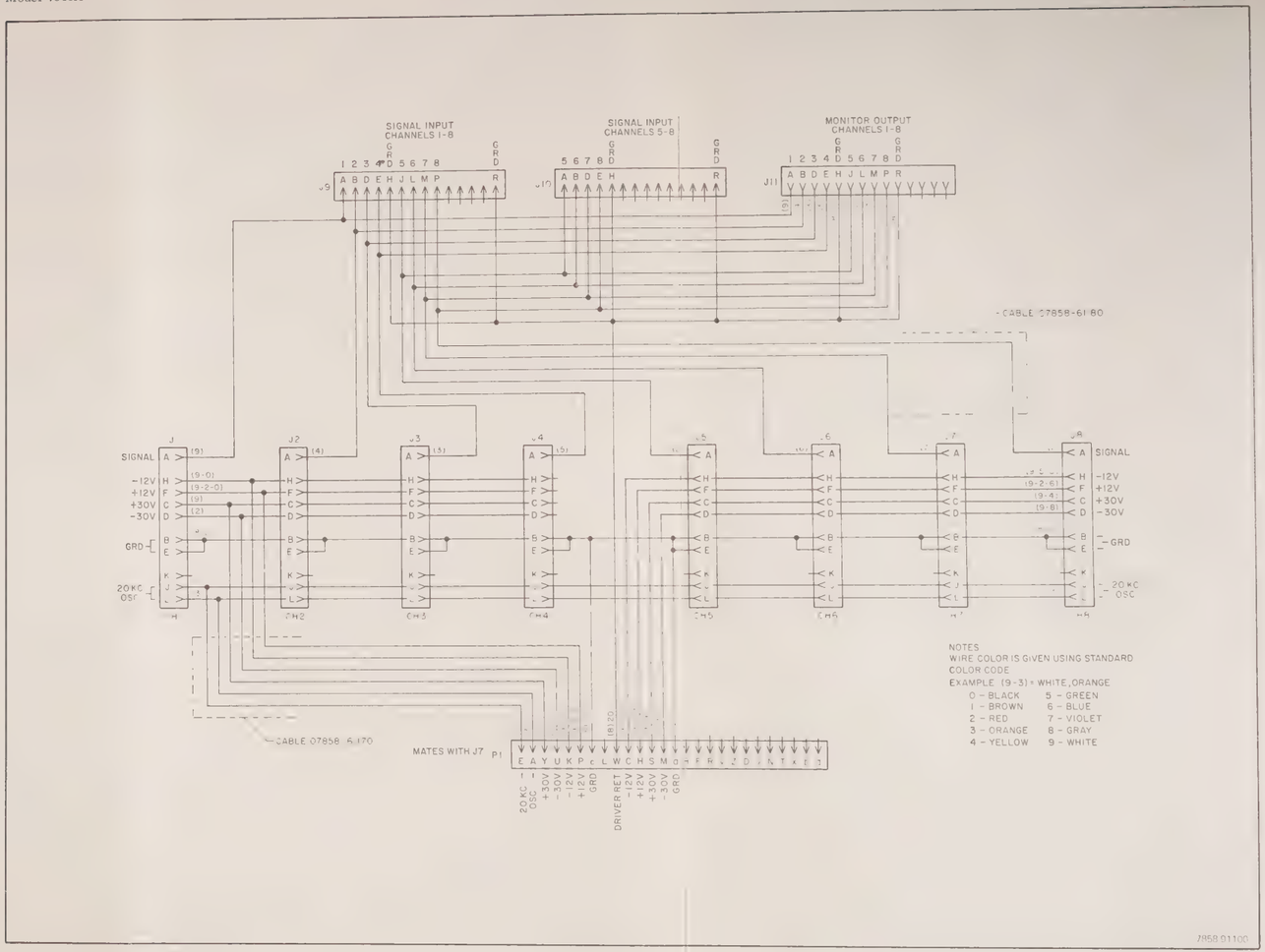


Figure 6A25. Transfer Chassis Schematic for Model 7848A

HEWLETT-PACKARD/SANBORN DIV.
175 WYMAN STREET
WALTHAM, MASS. 02154
TEL: TW-4-6300
MAY 31, 1967

REPLACEMENT PARTS LIST SUPPLEMENT
RPL-8800-01A thru 1G

8-CHANNEL POWER SUPPLY
MODEL 8800-01A

SUPPLEMENT TO SCHEMATIC DIAGRAM 08800-91000 SUB 0 and REPLACEABLE PARTS LIST RPL-8800-01A-1.

This errata updates the Schematic and parts list through PCO No. 15981.

A. Make the following changes to Schematic Diagram 08800-91000 SUB 0:

1. Change Note 8 to:

   POWER SUPPLIES AVAILABLE:

8800-03A	WITH 440 AND 2400 Hz CARDS.
OPTION 01	LESS 2400 Hz CARD.
OPTION 02	LESS 440 Hz CARD.
OPTION 03	40 kHz CARD SUBSTITUTED FOR 2400 Hz CARD.
OPTION 04	WITH 10 FT. POWER CORD.
OPTION 05	LESS STANDARD 3 FT. POWER CORD AND SLIDE KIT.
OPTION 07	LESS 07708-69020 SIGNAL CABLE.

2. Insert Figure 1 of this errata in place of 868-500A-C5 (40 kHz oscillator).

3. Delete T2. Connect CR7 cathode to T1, pin 3; Connect CR8 cathode to T1, pin 5.

4. Connect pin C of connectors J21 through J28 to ground.

5. On 868-500A-C6 (Regulator), change Q3 type to 2N2552.

6. On 868-500A-C14 (440 Hz Oscillator), change Q12, Q13 type to 2N2552.

7. Add Fuse F5 (0.25A fast-blow) between F4 and J32, pin F.

8. Add R44 (3300 Ohms) on J32 oscillator connector, as noted in Figure 1.

9. On 868-500A-C13 (2400 Hz Oscillator),
   --Insert C21 (.0056 Mfd) between emitter of Q19 and pin C of connector.
   --Change R37, R39 to 6800 Ohms.
   --Change CR24 breakdown value to 6.2V.
   --Change Q19 type to 2N4036.

B. Amend Parts List RPL-8800-01A-1 as follows:

1. Delete values and part numbers under following reference designations:

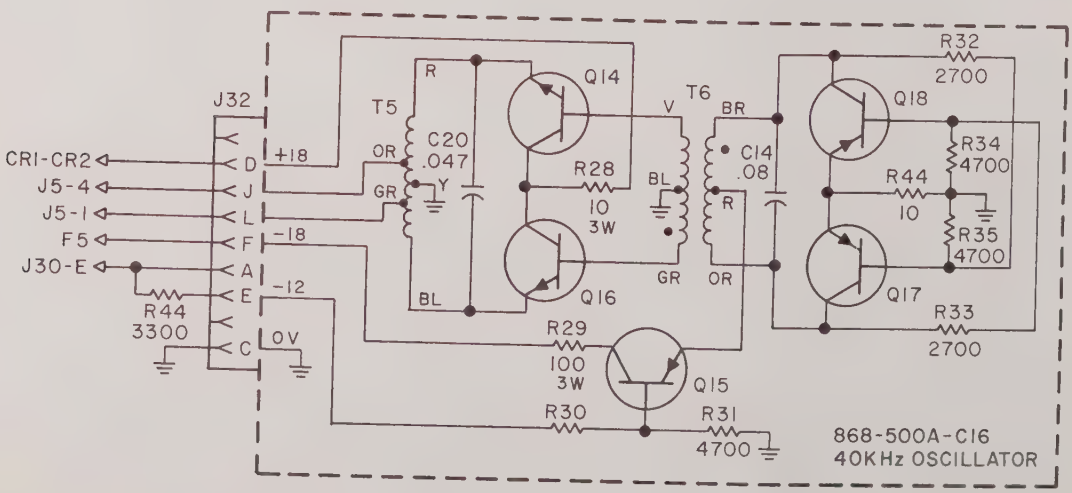
   C14, CR24, Q3, Q12 thru Q19, R28 thru R35, R37, R39, T5, T6, TM3, and TM4.

2. Change reference of $ key symbol to read:

   Oscillator Card (40 kHz) Assembly, 868-500A-C16.

3. Add following reference designations, values, quantities, and part numbers:

C14	.08 Mfd. capacitor	1	0160-2684	$
C20	.047 Mfd. capacitor	1	0160-2690	$
C21	.0056 Mfd. capacitor	1	0160-0158	Ω
CR24	6.2 V Zener diode	1	1902-0551	Ω
Q3	2N2552 transistor	3	1850-0181	&
Q12	same as Q3			∫
Q13	same as Q3			∫
Q14	2N3053 transistor	4	1854-0039	$
Q15	2N1131 transistor	1	1853-0019	$
Q16	same as Q14			$
Q17	same as Q14			$
Q18	same as Q14			$
Q19	2N4036 transistor	1	1853-0045	Ω
R28	10 Ohm, 5% 3W	1	0811-1718	$
R29	100 Ohm, 5% 3W	1	0813-0050	$
R30	100 Ohm, 5% 1/2W	1	0686-1015	$
R31	4700 Ohm, 5% 1/2W	3	0686-4725	$
R32	2700 Ohm, 5% 1/2W	2	0686-2725	$
R33	same as R32			$
R34	same as R31			$
R35	same as R31			$
R37	6800 Ohm, 5% 1/2W	2	0686-6825	Ω
R39	same as R37			Ω
R44	3300 Ohm, 5% 1/2W	1	0686-3325	√
R44	same as R22 △ (10 Ohm)		0686-1005	$
T5	Toroid, Output	1	9100-2041	$
T6	Toroid, Oscillator	1	9100-2038	$
XF5	Fuse Holder	1	2110-0246	√



SANBORN POWER SUPPLY
MODELS 8800-01A
8800-02A
8800-03A
8800-04A
SCHEMATIC: 08800-91000 SUB 0

SANBORN COMPANY
WALTHAM MASS.
APRIL 1964
CR14258 RPL-8800-01A-1

NOTES:
1. UNLESS OTHERWISE SPECIFIED
   (B) ALL CAPACITORS VALUES ARE IN MFD.
3. ALL VOLTAGES [illegible] FULL SCALE [illegible] IMPEDANCE VTVM
4. VOLTAGES INDICATED ARE MEASURED WITH POWER SUPPLY LOADED
5. DELE[illegible]
6. OSCILLATORS: OPTIO[illegible] ORDER ASSEMBLIES, 868-500A-C4 OSC. FOR [illegible]

CHANNEL-8
CHANNEL-7
CHANNEL-6
CHANNEL-5
CHANNEL-4
CHANNEL-3
CHANNEL-2
CHANNEL-1
RECORDER OUTPUT J34
(TYPICAL) REAR SIGNAL INPUT GND C GUARD SIGNAL INPUT + A − B
(TYPICAL) SIGNAL OUTPUT OR CARRIER BRIDGE EXCITATION + A GND − B
OUTPUT D
SERVO REF INPUT J F K C
(TYPICAL) GUARD SIGNAL INPUT + B A −
440 COMMON 9
SIGNAL OUTPUT + 2 − 5
SERVO-REFERENCE INPUT + 3 − 10
−12V 14
440 EXCITATION 11
40KC COMMON 1
40KC EXCITATION A
POWER GROUND 4
+12V 13
OUTPUT 12
−18V 7
+18V 8 6
TEST POINTS J33-7 −12V J33-8 GND J33-9 +12V
+18V UNREG
−18V UNREG
OSC SUPPLY F4 1.6A S.B.
SEE NOTE 4
J33-1 440~ 14VPP
J33-3 440~ COM
J33-4 440~ 14VPP
TEST POINTS
868-500A-C4(440~) SEE NOTE 6
868-500A-C14(440~) SEE NOTES 6 & 8
MATES WITH J31
F1 115V 1A S.B. 230V .5A S.B.
S1 115V 230V
J29 AC POWER INPUT
T1 T2 T3 T4 T5 T6 T7
F2 1.5A −18V
F3 1.5A +18V
J30
J31
J32
868-500A-C6 REGULATOR
868-500A-C5(40 KC) SEE NOTE 6 & 8
SEE NOTE 4
J33-2 40KC 5V RMS
J33-8 40KC COM
TEST POINTS
868-500A-C13(2400~) SEE NOTES 6 & 8

SYMBOL	DESCRIPTION	AMT.	SANBORN NO.	VENDOR CODE	LOCATION
CR1 thru CR10	Silicon Diode	12	16A-39	CER-69(SOL)	#, %
CR11	Stabistor Diode	5	16A-47	G130(TEX)	&
CR12	Same as CR11				
CR13	Same as CR11				
CR14	Zener Diode	1	16A-62	CODI1793(COM)	&
CR15	Same as CR1				
CR16	Same as CR11				
CR17	Same as CR11				
CR18	Same as CR1				
CR19	Zener Diode	1	16A-72	PRS6384(NAE)	√
CR21	200 PIV Silicon Diode	4	16A-39	CER-69(SOL)	△, ?
CR22	Same as CR21				
CR23	15 V ± 5% Zener Diode	2	16A-44	CODI790(COM)	△, ?
CR24	8 V Zener Diode	1	16A-17	A-17(NAE)	Ω
CR25	200 PIV Silicon Rectifier	2	16A-39	CER-69(SOL)	Ω
CR26	Same as CR25				
C1 thru C5	2000 Mfd. 25 V Elec. Capacitor	5	8C-100	KPEX11866(CD)	√
C6	250 Mfd. 3 VDCW Elec. Cap.	2	8C-60	NLW250-3(CD)	&
C7	100 Mfd. 25 V Elec. Capacitor	4	8C-40	30D107G025DH4(SPR)	%
C8	Same as C7				
C9	Same as C6				
C10	100 pf Ceramic Capacitor	1	8E-8	331-Z5U-101K(ER)	&
C11	Same as C7				
C12	Same as C7				
C13	50 Mfd. 50 V Elec. Capacitor	1	8C-54	NLW50-50(CD)	%
C14	.08 Mfd. Paper Capacitor	1	8B-144	VE1A803J(ELP)	$
C15	2.0 Mfd. Paper Capacitor	2	8B-42	P8292ZN14(AER)	△, ?
C16	10 Mfd. 50 V Elec Capacitor	2	8C-68	30D106G050CB4(SPR)	?
C17	Same as C16				
C18	.33 Mfd. Capacitor	1	8B-130	VE1A334K(ELP)	Ω
C19	.022 Mfd. Capacitor	1	8B-120	WMF(CD)	Ω
F1	1 Amp Slow Blow Fuse	1	26B-5	MDL-1(BUS)	√
	1/2 Amp Slow Blow Fuse	As Ord.	26B-29	MDL-1/2(BUS)	√
F2	1.5 Amp Fuse	2	26B-1MS	F02A250V14A(BUS)	√
F3	Same as F2				
F4	1.6 Amp Slow Blow Fuse	1	26B-24	MDL-1-6/10(BUS)	√
J1 thru J8	16 Contact Female Connector	8	10G16-1FX	CMS-7175(COM)	√
J11 thru J18	3 Contact Male Connector	8	10G3-34MX	(SAN)	√
J21 thru J28	9 Contact Female Connector	8	10B9-5FX	126-221(AMP)	√
J29	3 Contact Male Connector	1	10G3-9MX	7486G(GRY)	√
J30	10 Contact Female Connector	3	10B10-1FX	143-010-01(AMP)	√
J31	Same as J30				
J32	Same as J30				
J33	9 Contact Female Connector	1	10F9-1FX	RGK-9-31SL(CAN)	√
J34	9 Contact Male Connector	1	10F9-1MX	GK-9-32SL(CAN)	√
Q1	2N1501 Transistor	3	16T-41	2N1501(MH)	√
Q2	Same as Q1				
Q3	2N1038-1 Transistor	1	16T-38	2N1038-1(TEX)	&
Q4	2N1374 Transistor	2	16T-31	2N1374(TEX)	&
Q5	Same as Q4				
Q6	2N1973 Transistor	1	16T-47	2N1973(TEX)	&
Q7	2N1306 Transistor	2	16T-33	2N1306(GI)	&
Q8	Same as Q7				
Q9	Same as Q1				
Q10	2N301 Transistor	2	16T-27	2N301(CLE)	√
Q11	Same as Q10				
Q12	2N1038-1 Transistor	2	16T-38	2N1038-1(TEX)	?
	2N600 Transistor	2	16T-32	2N600(PHI)	∫
Q13	Same as both Q12				
Q14	2N600 Transistor	3	16T-32	2N600(PHI)	$
Q15	Same as Q14				
Q16	Same as Q14				
Q17	2N597 Transistor	2	16T-34	2N597(PHI)	$
Q18	Same as Q17				
Q19	2N1374 Transistor	3	16T-31	2N1374(TEX)	Ω
Q20	Same as Q19				
Q21	Same as Q19				
R1	1,000 Ohm ± 5% 1/4 W	4	50B-102J	CB(AB)	&
R2	Same as R1				
R3	1,000 Ohm ± 1% Dep. Car.	2	50H-102G	N-11(WEL)	&
R4	500 Ohm Potentiometer	1	56PA-11	TMKO-501-M(CEN)	&
R5	Same as R3				
R6	3,300 Ohm ± 5% 1/4 W	1	50B-332J	CB(AB)	&
R7	1,000 Ohm ± 5% 1/2 W	2	50AB-102J	EB(AB)	&
R8	Same as R7				
R9	Same as R1				
R10	680 Ohm ± 5% 1/4 W	1	50B-681J	CB(AB)	&
R11	Same as R1				
R12	500 Ohm ± 1% Dep. Car.	2	50H-501G	N-11(WEL)	&
R13	Same as R12				
R14	10K ± 5% 1/2 W	1	50AB-103J	EB(AB)	&
R15	4,700 Ohm ± 5% 1/4 W	1	50B-472J	CB(AB)	&
R16	270 Ohm ± 5% 1/4 W	1	50AB-271J	EB(AB)	&
R17	470 Ohm ± 5% 2 W Comp	1	52C-471J	HB(AB)	%
R21	10K ± 5% 1/2 W	2	50AB-103J	EB(AB)	△
	180 Ohm ± 5% 1/2 W	2	50AB-181J	EB1815(AB)	?
R22	10 Ohm ± 5% 1/2 W	1	50AB-100J	EB(AB)	△
	7.5 Ohm ± 5% 3 W WW	1	53B-7R5J	242E(SPR)	?
R23	470 Ohm ± 5% 1/2 W	1	50AB-471J	EB(AB)	△
	1.8 K ± 5% 1/2 W	1	50AB-182J	EB(AB)	?
R24	470 Ohm ± 5% 1/2 W	1	50AB-471J	EB(AB)	△
	1.8 K ± 5% 1/2 W	1	50AB-182J	EB(AB)	?
R25	Same as Both R21				
R26	470 Ohm ± 5% 1/2 W	1	50AB-471J	EB(AB)	△
	1.8 K ± 5% 1/2 W	1	50AB-182J	EB(AB)	?
R27	470 Ohm ± 5% 1/2 W	1	50AB-471J	EB(AB)	△
	1K ± 5% 1/2 W	1	50AB-102J	EB(AB)	?
R28	33 Ohm ± 5% 1 W Comp	1	51D-330J	GB(AB)	$
R29	8200 Ohm ± 5% 1/2 W	2	50AB-822J	EB(AB)	$
R30	10 Ohm ± 5% 1/2 W	1	50AB-100J	EB(AB)	$
R31	Same as R29				
R32	470 Ohm ± 5% 1/2 W	4	50AB-471J	EB(AB)	$
R33	Same as R32				
R34	Same as R32				
R35	Same as R32				
R36	120 Ohm ± 5% 1/2 W	1	50AB-121J	EB1215(AB)	%
R37	8200 Ohm ± 5% 1/2 W	2	50AB-822J	EB(AB)	Ω
R38	10 Ohm ± 5% 1/2 W	1	50AB-100J	EB1005(AB)	Ω
R39	Same as R37				
R40	470 Ohm ± 5% 1/2 W	4	50AB-471J	EB4715(AB)	Ω
R41	Same as R40				
R42	Same as R40				
R43	Same as R40				
S1	DPDT Slide Switch	1	62D-54	3101-0033(HP)	
T1	Power Transformer	2	66B-200	(SAN)	
T2	Same as T1				
T3	Output Transformer	1	66B-102MS	(SAN)	
T4	Toroidal Oscillator (440 cps)	2	66B-172	(SAN)	
T5	Output Toroidal Coil	1	66B-195	[illegible]	
T6	Osc. Toroidal Coil	1	66B-171	[illegible]	
T7	Toroidal Osc Trans. 2400 Cycle	1	66B-218	[illegible]	
TM1	310 Ohm Cycleweld Thermistor	2	56T-3	23E3(VIC)	
TM2	Same as TM1				
TM3	310 Ohm Cycleweld Thermistor	2	56T-3	23E3(VIC)	
TM4	Same as TM3				
TM7	310 Ohm -3.8% per °C	2	56T-3	23E3(VIC)	
TM8	Same as TM7				

ACCESSORIES

9 Contact Male Connector	As Ord	10B9-5MW	126-220(AMP)
9 Contact Male Conn. Less Shell		10F9-3MW	
9 Contact Female Conn. Less Shell	As Ord.	10F9-3FW	
45° Shell	As Ord	10F9-3FWA	
3 Contact Female Connector	8	10G3-34FW	[illegible]
1.5 Amp Fuse	2	26B-1MS	F02[illegible]V14A(BUS)
1 Amp Slow Blow Fuse	1	26B-5	MDL-1(BUS)
1.6 Amp Slow Blow Fuse	1	26B-24	[illegible]
1/2 Amp Slow Blow Fuse	As Ord	26B-29	MDL-1/2(BUS)

KEY

&	Regulator Card Assembly	868-500A-C6
#	Diode Wiring (E1) Assembly	868-500A-[illegible]
~	Printed Board Assembly	[illegible]
√	Chassis Assembly	08800-61020
?	440 Cycle Oscillator Card & Bracket Assembly	868-500A-C14
△	P.C. Board (440 Cycle) Assembly	868-500A-C11
∫	Oscillator Card (440 Cycle) Assembly	868-500A-C4
$	Oscillator Card (40KC) Assembly	868-500A-C5
Ω	2400 Cycle Oscillator Card Assembly	868-500A-C13

VENDOR ABBREVIATIONS

AB	Allen Bradley
AER	Aerovox
AMP	Amphenol
BUS	Bussman
CAN	Cannon
CD	Cornell Dubilier
CEN	Centralab
CLE	Clevite
COM	Computer Diode
ELP	Elpac
ER	Erie
GI	General Instrument
GRY	Graybar
HP	Hewlett Packard
IRC	International Resistance Corp.
MH	Minneapolis Honeywell
NAE	North American Electric
PHI	Philco
SAN	Sanborn
SOL	Solitron Devices
SPR	Sprague
TEX	Texas Instrument
VIC	Victory Engineering Corp.
WEL	Welwyn

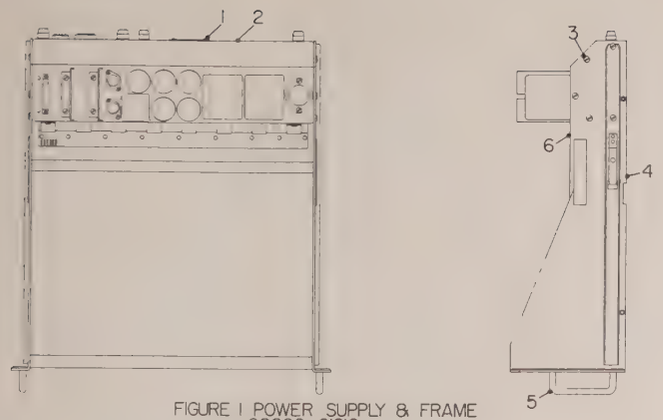
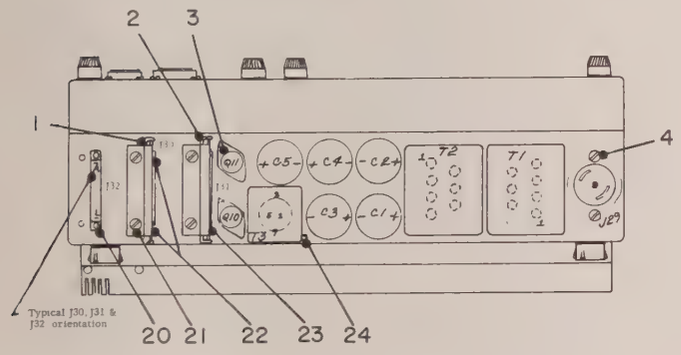
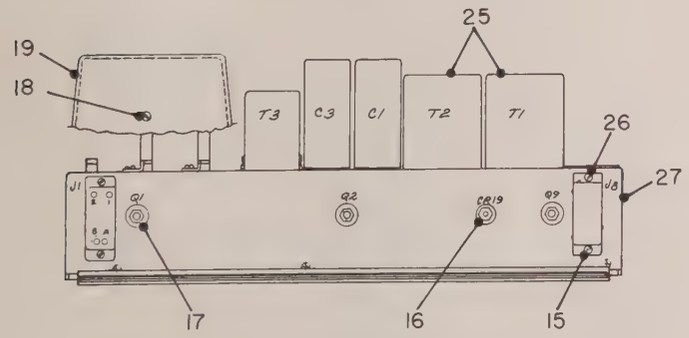


FIGURE 1 POWER SUPPLY & FRAME
08800-61010

FIGURE 1. POWER SUPPLY & FRAME ASSY, 08800-61010

REF. NO.	DESCRIPTION	SANBORN NO.
1	2-56 x 3/16 Lg. Sems	83A-2-3B
2	Chassis Assy. See fig 2	08800-61020
3	8-32 x 3/8 Lg. Sems	83A-8-6B
4	Spring Lock Assembly See figure 4.	868-500A-C8
5	Lift Handle	67-1230
	8-32 x 3/8 Lg. Screw	80A-832-6D
6	Spring Lock Assembly See figure 4	868-500A-C8





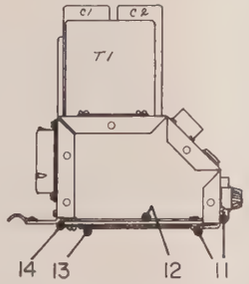


FIGURE 2. CHASSIS ASSEMBLY
08800-61020

FIGURE 2. CHASSIS ASSEMBLY, 08800-61020

REF. NO.	DESCRIPTION	SANBORN NO.
1	Reg. Assy. (See fig. 5)	868-500A-C6
2	Oscillator Assy.	
3	6-32 x 1/2 Lg. Screw	84D-6-8B
	Transistor Insulator	74T-5
4	6-32 x 1/4 Lg. Sems	83A-6-4B
5	4-40 x 5/16 Lg. Screw	80A-440-5C
	4-40 Keps	40T-4
6	4-40 x 5/16 Lg. Screw	80A-440-5C
	4-40 Keps	40T-4
7	6-32 Keps	40T-6
	6-32 x 3/8 Lg. Sems	83A-6-6B
8	4-40 x 3/8 Lg. Sems	83A-4-6B
9	Backing Strip	751-10-P10
	Diode Wiring (E1) Assy (See figure 6)	868-500A-C7
10	4-40 Keps	40T-4
	4-40 x 3/8 Lg. Sems	83A-4-6B
11	4-40 x 5/16 Lg. Sems	83A-4-5B
12	Bracket	801-158
13	P.C. Board Cover	868A-504
14	Printed Circuit Board Assy (See figure 6)	868-500A-C9
15	4-40 x 1/2 Lg. Sems	83A-4-8B
	RA Lug	34A-5
	4-40 Keps	40T-4
	#4 Lockwasher	73A-4
16	#10 Kep Nut	40T-10
	#10 Anodized Washer	74T-3
17	Anodized Washer	74T-1
18	4-40 x 1/4 L. Screw	80N-440-4B
19	Cover	868A-505
20	4-40 x 1/2 Lg. Sems	83A-4-8B
21	6-32 x 1/4 Lg. Sems	83A-6-4B
22	4-40 x 1/2 Lg. Sems	83A-4-8B
23	4-40 x 1/2 Lg. Sems	83A-4-8B
24	6-32 Keps	40T-6
25	6-32 Keps	40T-6
26	4-40 x 3/8 Lg. Sems	83A-4-6B
27	Chassis (Inseparable) (See figure 3)	868-500A-C3

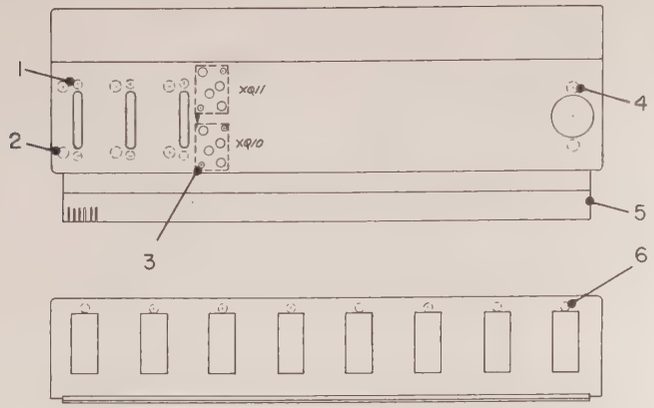
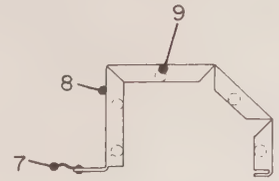


FIGURE 3. CHASSIS INSEPARABLE ASSEMBLY
868-500A-C3

FIGURE 3. CHASSIS INSEPARABLE ASSEMBLY, 868-500A-C3

REF. NO.	DESCRIPTION	SANBORN NO.
1	4-40 Pem	[illegible]
2	6-32 Pem	[illegible]
3	1/8 x 3/16 Lg. Rivet	[illegible]
4	6-32 Pem	[illegible]
5	1/8 x 5/32 Lg. Rivet	[illegible]
6	4-40 Pem	[illegible]
7	Finger Contact Strip	[illegible]
8	Chassis	868A-[illegible]
9	8-32 Pem	40P-8-2



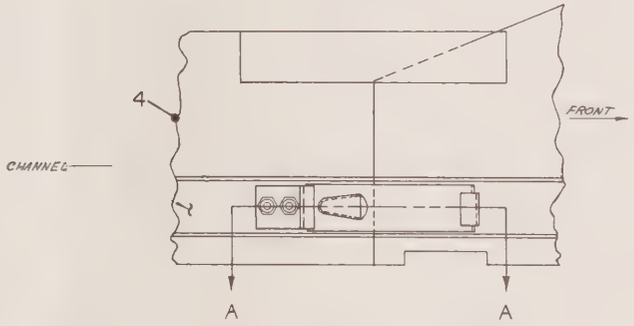
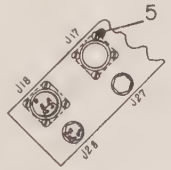


FIGURE 4. RACK AND SPRING LOCK ASSEMBLY
868-500A-C8



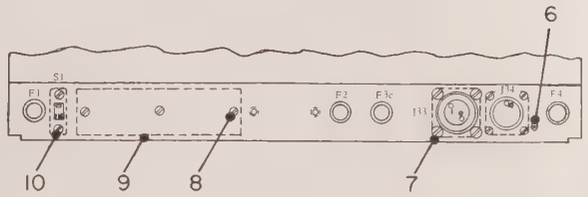


FIGURE 4. RACK & SPRING LOCK ASSEMBLY, 868-500A-C8

REF. NO.	DESCRIPTION	SANBORN NO.
1	4-40 x 3/16 Lg. Sems	[illegible]
	4-40 Stop Nut	[illegible]
2	Lock Pressed	[illegible]
3	Lock Spring	[illegible]
4	Mounting Rack	868A-501
5	Pressure Lock Spring	354-1116

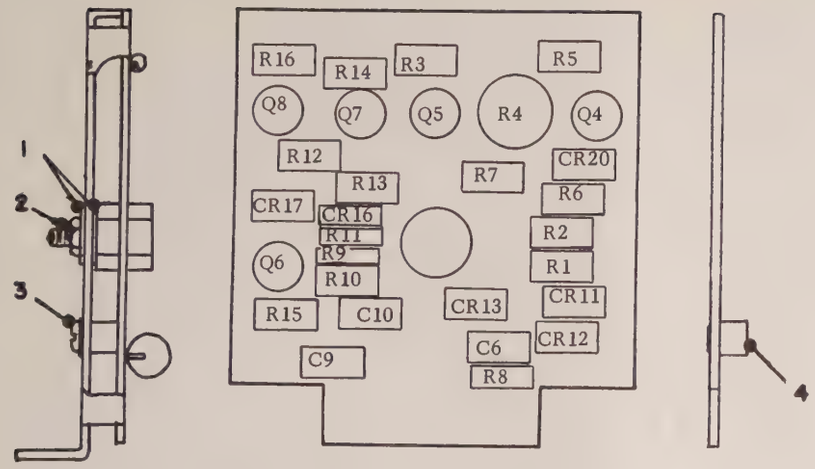


FIGURE 5. REGULATOR CARD ASSEMBLY
868-500A-C6

FIGURE 5. REGULATOR CARD ASSEMBLY, 868-500A-C6

REF. NO.	DESCRIPTION	SANBORN NO.
1	Anodized Washer	74T-3
2	Flat Washer	74A-10L
	Kep Nut	40T-10
3	6-32 x 5/16 Lg. Sems	83A-6-5B
4	1/4 x 3/16 Lg. Spacer	47K-12

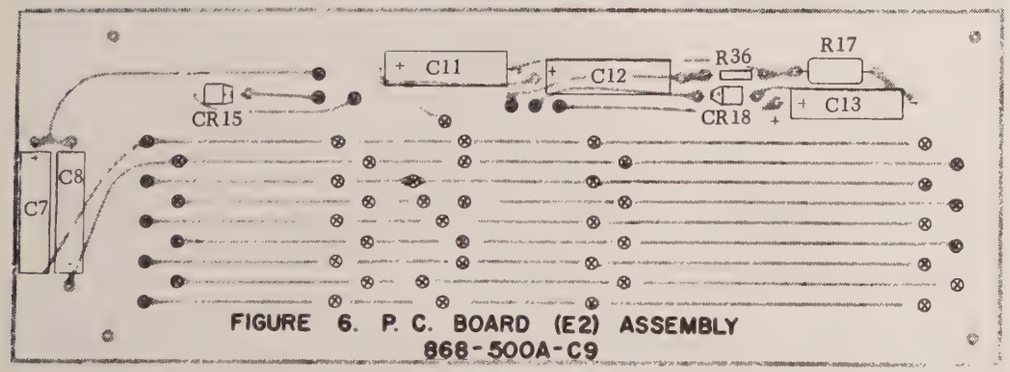


FIGURE 6. P. C. BOARD (E2) ASSEMBLY
868-500A-C9

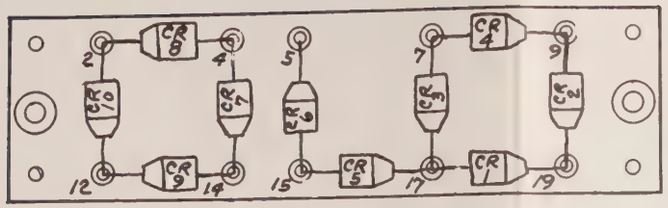


FIGURE 7. DIODE WIRING (E1) ASSEMBLY
868-500A-C7

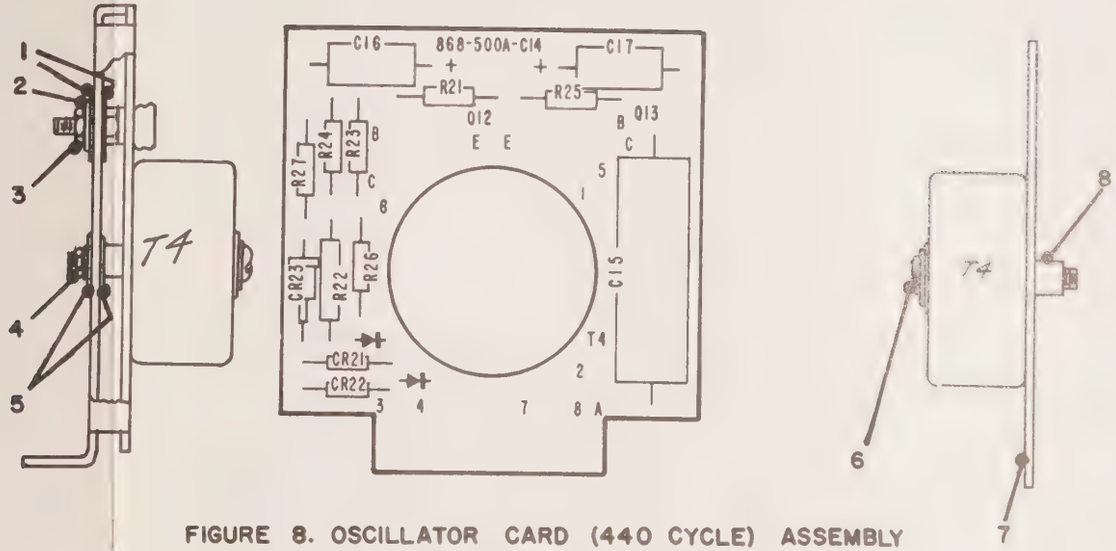
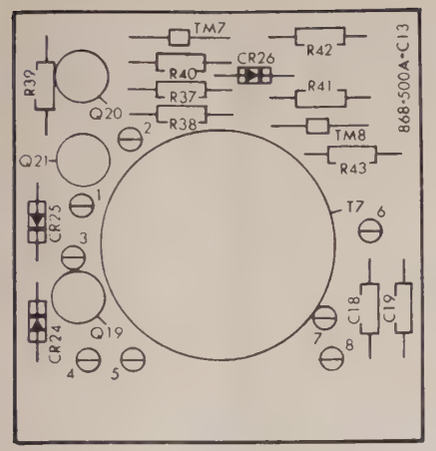


FIGURE 8. OSCILLATOR CARD (440 CYCLE) ASSEMBLY
868-500A-C14

FIGURE 8. OSCILLATOR CARD (440 CYCLE) ASSY. 868-500A-C14

REF. NO.	DESCRIPTION	SANBORN NO.
1	Anodized Washer	74T-3
2	#10 Flat Washer	74A-10S
3	#10 Keps Nut	40T-10
4	#6 Keps Nut	40T-6
5	Anodized Washer	74T-1
6	6-32 x 1 1/4 Lg. Screw	80A-632-20B
	Fiber Washer	74F-6A
	Flat Washer	74A-6L
7	Printed Board	752-363
8	1/4 x 3/16 Lg. Spacer	47K-12



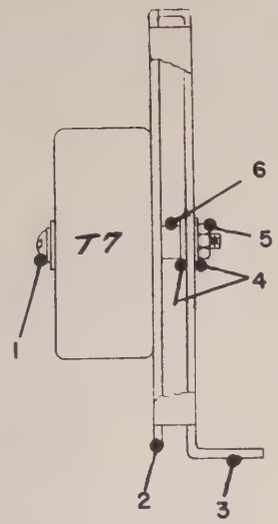
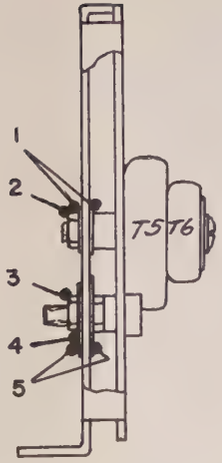


FIGURE 9. 2400 CYCLE OSCILLATOR CARD ASSEMBLY 868-500A-C13

FIGURE 9. 2400 CYCLE OSCILLATOR CARD ASSY, 868-500A-C13

REF. NO.	DESCRIPTION	SANBORN NO.
1	6-32 x 1 1/4 Lg. Screw	80A-632-20B
	#6 Fiber Washer	74F-144
	Flat Washer	74A-6L
2	Printed Board	752-353
3	Bracket	801-157
4	Anodized Washer	74T-1
5	#6 Keps	40T-6
6	1/4 x 3/16 Lg. Spacer	47K-12



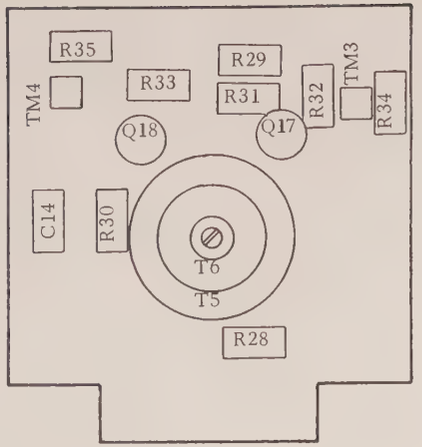


FIGURE 10. OSCILLATOR CARD ASSEMBLY (40KC) 868-500A-C5

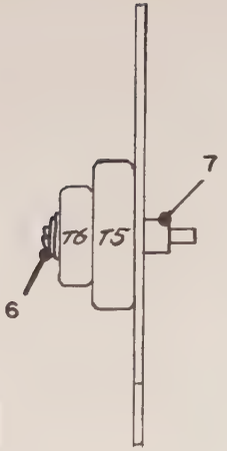
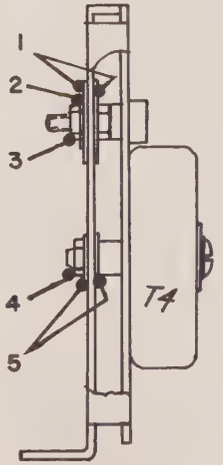


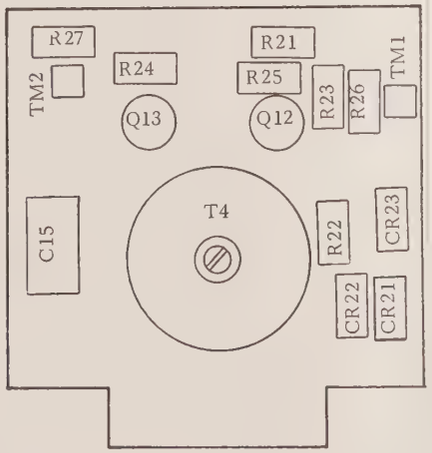
FIGURE 10. OSCILLATOR CARD ASSEMBLY (40KC) 868-500A-C5

REF. NO.	DESCRIPTION	SANBORN NO.
1	Anodized Washer	74T-1
2	#6 Kep Nut	40T-6
3	#8 Keps Nut	40T-8
4	#8 Flat Washer	74A-8L
5	Anodized Washer	74T-1
6	Fiber Washer	74F-6A
	Flat Washer	74A-6L
	6-32 x 1 1/4 Lg. Screw	80A-632-20B
7	1/4 x 3/16 Lg. Spacer	47K-12

FIGURE 11. OSCILLATOR CARD (440 CYCLE) ASSY. 868-500A-C4

REF. NO.	DESCRIPTION	SANBORN NO.
1	Anodized Washer	74T-1
2	#8 Flat Washer	74A-8L
3	#8 Kep Nut	40T-8
4	#6 Kep Nut	40T-6
5	Anodized Washer	74T-1
6	6-32 x 1 1/4 Lg. Screw	80A-632-20B
	Fiber Washer	74F-6A
	Flat Washer	74A-6L
7	Printed Board	752-225
8	1/4 x 3/16 Lg. Spacer	47K-12





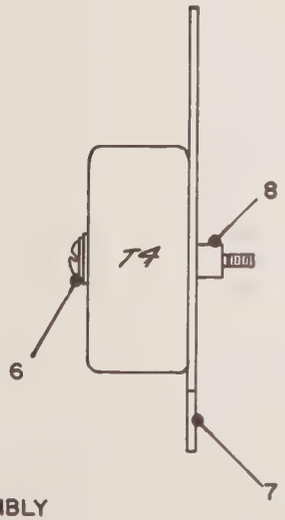


FIGURE 11. OSCILLATOR CARD (440 CYCLE) ASSEMBLY 868-500A-C4

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SCHEMATIC

08820-90000

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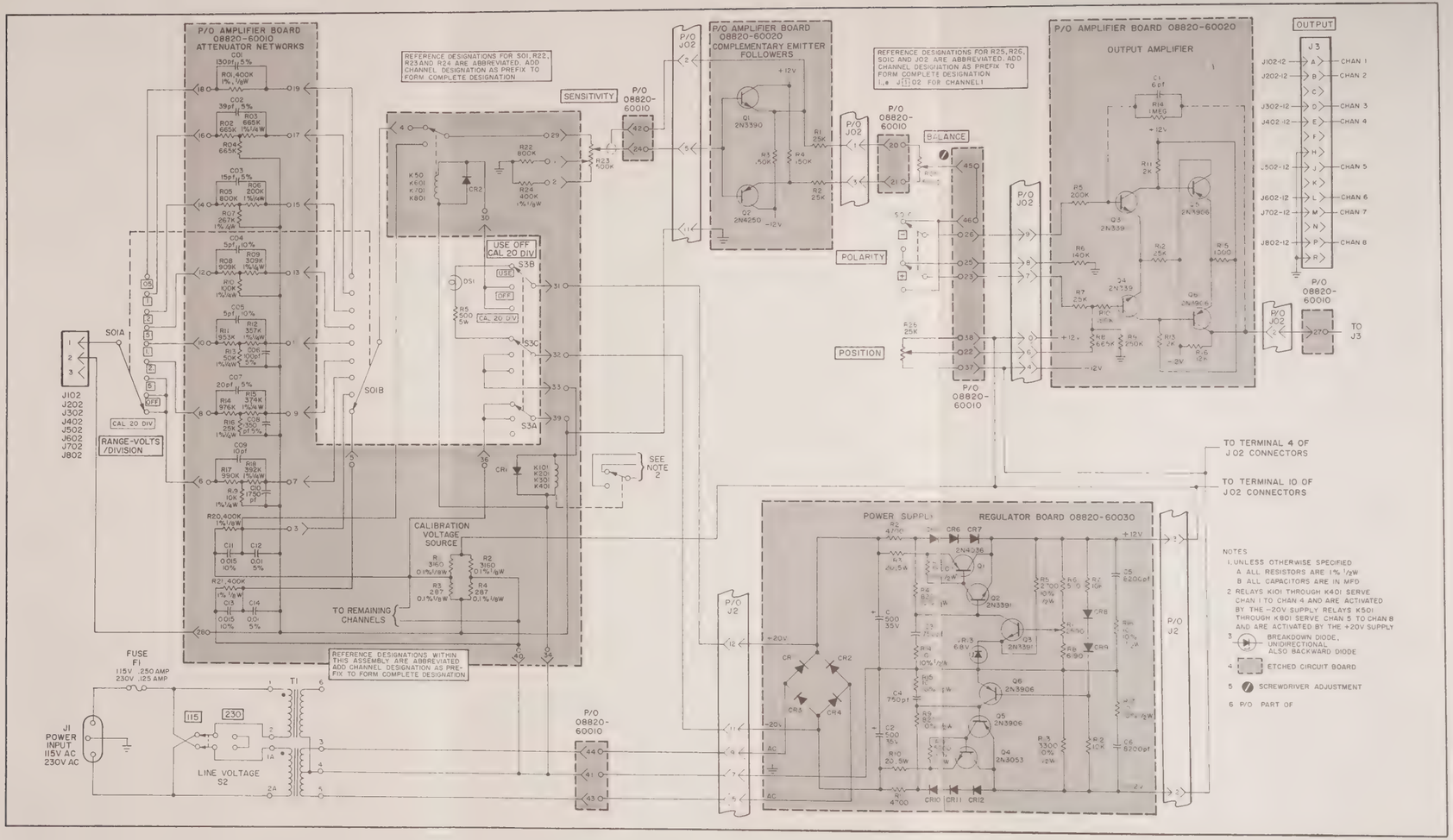
P/O AMPLIFIER BOARD 08820-60010 ATTENUATOR NETWORKS
REFERENCE DESIGNATIONS FOR S01, R22, R23 AND R24 ARE ABBREVIATED. ADD CHANNEL DESIGNATION AS PREFIX TO FORM COMPLETE DESIGNATION
SENSITIVITY
P/O 08820-60010
P/O AMPLIFIER BOARD 08820-60020 COMPLEMENTARY EMITTER FOLLOWERS
REFERENCE DESIGNATIONS FOR R25, R26, S01C AND J02 ARE ABBREVIATED. ADD CHANNEL DESIGNATION AS PREFIX TO FORM COMPLETE DESIGNATION i.e. J[1]02 FOR CHANNEL1
P/O AMPLIFIER BOARD 08820-60020 OUTPUT AMPLIFIER
OUTPUT
BALANCE
POLARITY
POSITION
USE OFF CAL 20 DIV
SOIA
SOIB
J102 J202 J302 J402 J502 J602 J702 J802
CAL 20 DIV
RANGE-VOLTS /DIVISION
CALIBRATION VOLTAGE SOURCE
TO REMAINING CHANNELS
REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD CHANNEL DESIGNATION AS PREFIX TO FORM COMPLETE DESIGNATION
FUSE F1 115V .250 AMP 230V .125 AMP
J1 POWER INPUT 115V AC 230V AC
LINE VOLTAGE S2
TO TERMINAL 4 OF J02 CONNECTORS
TO TERMINAL 10 OF J02 CONNECTORS
POWER SUPPLY REGULATOR BOARD 08820-60030
SEE NOTE 2
NOTES
1. UNLESS OTHERWISE SPECIFIED
A ALL RESISTORS ARE 1% 1/2W
B ALL CAPACITORS ARE IN MFD
2 RELAYS K101 THROUGH K401 SERVE CHAN 1 TO CHAN 4 AND ARE ACTIVATED BY THE -20V SUPPLY RELAYS K501 THROUGH K801 SERVE CHAN 5 TO CHAN 8 AND ARE ACTIVATED BY THE +20V SUPPLY
3 BREAKDOWN DIODE, UNIDIRECTIONAL, ALSO BACKWARD DIODE
4 ETCHED CIRCUIT BOARD
5 SCREWDRIVER ADJUSTMENT
6 P/O PART OF

Figure 6B1. 8820A Amplifier Schematic

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Pointe Claire
Tel: (514) 697-4232
TWX: 610-422-3022
Telex: 01-2819

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CENTRAL AND SOUTH AMERICA

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Mauricio A. Suárez
Telecomunicaciones
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Buenos Aires
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BRAZIL
Ciental, Importacao e
Comércio Ltda.
Avenida 13 de Maio, 13-22° andar
Rio de Janeiro G.B.
Tel: 42-9483

Ciental, Importacao e
Comércio Ltda.
Rua Des. Eliseu Guilherme, 62
Sao Paulo 8
Tel: 70-2318
Cable: CIENTALCO, Sao Paulo

CHILE
Héctor Calcagni
Casilla 13942
Santiago
Tel: 490.505, 393.119

COLOMBIA
Instrumentacion
Henrik A. Langebaek & Cia. Ltda.
Cra. 7A N° 48-51/59
Apartado Aereo 6287
Bogota, 1 D.E.
Tel: 45-78-06, 45-55-46
Cable: AARIS Bogota

COSTA RICA
Lic. Alfredo Gallegos Gurdián
Apartado 3243
San José
Tel: 21-86-13
Cable: GALGUR San José

ECUADOR
Laboratorios de Radio-Ingenieria
Calle Guayaquil 1246
Post Office Box 3199
Quito
Tel: 12496
Cable: HORVATH Quito

EL SALVADOR
Electrónica
27 Avenida Norte 1133
Apartado Postal 1589
San Salvador
Tel: 25-74-50
Cable: ELECTRONICA
San Salvador

GUATEMALA
Olander Associates Latin America
Apartado 1226
7a. Calle, 0-22, Zona 1
Guatemala City
Tel: 22812
Cable: OLALA Guatemala City

MEXICO
Hewlett-Packard Mexicana,
S.A. de C.V.
Eugenia 408, Dept. 1
Mexico 12, D.F.
Tel: 43-03-79

NICARAGUA
Roberto Terán G.
Edificio Terán
Apartado Postal 689
Managua
Tel: 3451, 3452
Cable: ROTERAN Managua

PANAMA
Electrónica Balboa, S.A.
P.O. Box 4929
Ave. Manuel Espinosa No. 13-50
Bldg. Alina
Panama City
Tel: 30833
Cable: ELECTRON Panama City

PERU
Fernando Ezeta B.
Av. Petit Thouars 4719
Miraflores
Casilla 3061
Lima
Tel: 50346
Cable: FEPERU Lima

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San Juan Electronics, Inc.
P.O. Box 5167
Ponce de León 150, Stop 3
Puerta de Tierra Santa
San Juan 00906
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Cable: SATRONICS San Juan

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S.A. Comercial e Industrial
Avenida Italia 2877
Casilla de Correo 370
Montevideo
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Cable: RADIUM Montevideo

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Edif. Arisan-Of. #4
Avda. Francisco de Miranda
Apartado del Este 10934 Chacaito
Caracas
Tel: 71.88.05
Cable: CITECAL Caracas

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Cable: PALOBEN Brussels

DENMARK
Tage Olsen A/S
Ronnegade 1
Copenhagen o
Tel: 29 48 00
Cable: TOCOPEN Copenhagen

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Cable: HEWPACK Paris

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Lietzenburger Strasse 30
1 **Berlin W** 30
Tel: 24 86 36

Hewlett-Packard Vertriebs-GmbH
Herrenberger Strasse 110
703 **Böblingen**, Württemberg
Tel: 07031-6971
Cable: HEPAG Boblingen

Hewlett-Packard Vertriebs-GmbH
Achenbachstrasse 15
4 **Düsseldorf** 1
Tel: 68 52 58/59

Hewlett-Packard Vertriebs-GmbH
Kurhessenstrasse 95
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Cable: HEWPACKSA Frankfurt

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Beim Strohhause 26
2 **Hamburg** 1
Tel: 24 05 51/52
Cable: HEWPACKSA Hamburg

Hewlett-Packard Vertriebs-GmbH
Reginfriedstrasse 13
8 **Munich** 9
Tel: 69 51 21/22
Cable: HEWPACKSA Munich

GREECE
Kostos Karayannis
18, Ermou Street
Athens 126
Tel: 230 301
Cable: RAKAR Athens

IRELAND
Hewlett-Packard Ltd.
224 Bath Road
Slough, Bucks, England
Tel: Slough 28406-9, 29486-9
Cable: HEWPIE Slough

ITALY
Hewlett-Packard Italiana S.p.A.
Viale Lunigiana 46
Milan
Tel: 69 15 84
Cable: HEWPACIT Milan

Hewlett-Packard Italiana S.p.A.
Palazzo Italia
Piazza Marconi 25
Rome - Eur
Tel: 591 2544
Cable: HEWPACIT Rome

NETHERLANDS
Hewlett-Packard Benelux, N.V.
de Boelelaan 1043
Amsterdam, Z.2
Tel: 42 77 77
Cable: PALOBEN Amsterdam

NORWAY
Morgenstierne & Co. A/S
Ingeniofirma
6 Wessels Gate
Oslo
Tel: 20 16 35
Cable: MOROF Oslo

PORTUGAL
Telectra
Rua Rodrigo da Fonseca 103
P.O. Box 2531
Lisbon 1
Tel: 68 60 72
Cable: TELECTRA Lisbon

SPAIN
Ataio Ingerieros
Urgel, 259
Barcelona, 11
Tel: 230-69-88

Ataio Ingenieros
Enrique Larreta 12
Madrid, 16
Tel: 235 43 44
Cable: TELEATAIO Madrid

SWEDEN
HP Instrument AB
Hagakersgatan 7
Mölndal
Tel: 031 - 27 68 00

HP Instrument AB
Centralvägen 28
Solna
Tel: 08 - 83 08 30
Cable: MEASUREMENTS Stockholm

SWITZERLAND
HEWPAK AG
Zurcherstrasse
8952 Schlieren
Zurich
Tel: (051) 98 18 21
Cable: HEWPACKAG Zurich

TURKEY
Telekom Engineering Bureau
P.O. Box 376 - Galata
Istanbul
Tel: 49 40 40
Cable: TELEMATION Istanbul

UNITED KINGDOM
Hewlett-Packard Ltd.
224 Bath Road
Slough, Bucks
Tel: Slough 28406-9, 29486-9
Cable: HEWPIE Slough

YUGOSLAVIA
Belram S.A.
83 avenue des Mimosas
Brussels 15, Belgium
Tel: 35 29 58
Cable: BELRAMEL Brussels

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AFRICA, ASIA, AUSTRALIA

AUSTRALIA
Hewlett-Packard Australia Pty. Ltd.
22-26 Weir Street
Glen Iris, S. E. 6
Victoria
Tel: 20-1371 (4 lines)
Cable: HEWPARD Melbourne

Hewlett-Packard Australia Pty. Ltd.
4 Grose Street
Glebe, New South Wales
Tel: 211-2235, 211-2888
Cable: HEWPARD Sydney

CEYLON
United Electricals Ltd.
P.O. Box 681
Yahala Building
Staples Street
Colombo 2
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Cable: HOTPOINT Colombo

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P. O. Box 718
Addis Ababa
Tel: 44090
Cable: ASACO Addisababa

HONG KONG
Schmidt & Co. (Hong Kong) Ltd.
P.O. Box 297
1511, Prince's Building
10, Chater Road
Hong Kong
Tel: 240168, 232735
Cable: SCHMIDTCO Hong Kong

INDIA
The Scientific Instrument Co., Ltd.
6, Tej Bahadur Sapru Road
Allahabad 1
Tel: 2451
Cable: SICO Allahbad

The Scientific Instrument Co., Ltd.
240, Dr. Dadabhai Naoroji Road
Bombay 1
Tel: 26-2642
Cable: SICO Bombay

The Scientific Instrument Co., Ltd.
11, Esplanade East
Calcutta 1
Tel: 23-4129
Cable: SICO Calcutta

The Scientific Instrument Co., Ltd.
30, Mount Road
Madras 2
Tel: 86339
Cable: SICO Madras

The Scientific Instrument Co., Ltd.
B-7, Ajmeri Gate Extn.
New Delhi 1
Tel: 27-1053
Cable: SICO New Delhi

IRAN
Telecom, Ltd.
P. O. Box 1812
Teheran
Tel: 43850, 48111
Cable: BASCOM Teheran

ISRAEL
Electronics & Engineering Div. of Motorola Israel Ltd.
16, Kremenetski Street
Tel-Aviv
Tel: 35021/2/3
Cable: BASTEL Tel-Aviv

JAPAN
Yokogawa-Hewlett-Packard Ltd.
Shinhankyu Building
No. 8, Umeda
Kita-ku, **Osaka** City
Tel: 0726-23-1641

Yokogawa-Hewlett-Packard Ltd.
Ito Building
No. 59, Kotori-cho
Nakamura-ku, **Nagoya** City
Tel: 551-0215

Yokogawa-Hewlett-Packard Ltd.
Ohashi Building
No. 59, I-chome, Yoyogi
Shibuya-ku, **Tokyo**
Tel: 370-2281
Cable: YOKOHEWPACK Tokyo
Telex: 232-2034

KENYA
R. J. Tilbury Ltd.
P. O. Box 2754
Suite 517/518
Hotel Ambassadeur
Nairobi
Tel: 25670, 26803, 68206
Cable: ARJAYTEE Nairobi

KOREA
American Trading Co., Korea, Ltd.
Seoul P. O. Box 1103
112-35 Sokong-Dong
Jung-ku, **Seoul**
Tel: 3.7049, 3.7613
Cable: AMTRACO Seoul

LEBANON
Constantin E. Macridis
Clemenceau Street
Clemenceau Center
Beirut
Tel: 220846
Cable: ELECTRONUCLEAR Beirut

MALAYSIA
MECOMB Malaysia Ltd.
2 Lorong 13/6A
Section 13
Petaling Jaya, **Selangor**
Cable: MECOMB Kuala Lumpur

NEW ZEALAND
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8 Matipo Street
Onehunga S.E. 5
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Cable: ELPMAS Auckland

PAKISTAN (EAST)
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Tel: 80058
Cable: COOPERATOR Dacca

PAKISTAN (WEST)
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Oosman Chambers
Victoria Road
Karachi 3
Tel: 51027, 52927
Cable: COOPERATOR Karachi

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Tel: 642361-3
Cable: MECOMB Singapore

SOUTH AFRICA
F. H. Flanter & Co. (Pty.), Ltd.
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Tel: 3-3817
Cable: AUTOPHONE Cape Town

F. H. Flanter & Co. (Pty.), Ltd.
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Braamfontein, **Johannesburg**
Tel: 724-4172

TAIWAN
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Taipei
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Cable: VICTRONIX Taipei

THAILAND
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Bangkok
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VIETNAM
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P.O. Box H-3
216 Hien-Vuong
Saigon
Tel: 20.805
Cable: LANBROCOMP Saigon

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